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CONTENTS

	Page
Scientific Advances and Industrial Development	145
Lysenko in Perspective. By Dr. E. Ashby	148
The Rise of Evolutionary Concepts. By the late Prof. F. E. Fritsch, F.R.S.	149
Progress in Nuclear Physics. By Sir John Cockcroft, K.C.B., C.B.E., F.R.S.	150
Sugar Technology. By H. C. S. de Whalley	150
British Medusæ. By Prof. T. A. Stephenson, F.R.S.	151
The Reopening of Pulkovo Observatory. By D. H. Sadler	153
A Great Haul of Ambergris. By Robert Clarke	155
Some Chemical Aspects of Abnormal Growth. By Prof. F. Bergel	156
Obituary: Prof. T. G. Hill. By Dr. D. J. B. White	159
News and Views	160
University Affairs in Great Britain, 1952–53	165
Science in the Extra-Mural Work of Universities	166
Nutrition and the Liver: Symposium in Glasgow. By Dr. H. N. Munro	167
Third International Rubber Technology Conference. By F. A. Jones	168
Stanford Research Institute, California: Report for 1953	170
Chemical Research Laboratory, Teddington: Report for 1953	170
The Ice Ages and Past Variations of the Earth's Climate	172
Winchester College Natural History Society	172
Forestry in New Zealand. By Prof. E. P. Stebbing	173
New Observations on the Chemistry of N-Carboxy-Alpha-Amino-acid Anhydrides. By D. G. H. Ballard, Dr. C. H. Bamford and Dr. F. J. Weymouth	173
Letters to the Editors:	
Radio Observations of Ionized Hydrogen Nebulæ and Other Discrete Sources at a Wave-length of 9·4 cm.—F. T. Haddock, C. H. Mayer and R. M. Sloanaker	176
Ferromagnetic Resonance in Ferrites.—P. A. Miles	177
Use of X-Ray Film for comparing Radioactivities.—A. N. Davenport and G. W. W. Stevens	178
Bond-Lengths and Force Constants for Methane, Silane and Germane.—R. A. Ballinger and N. H. March	179
Some 2 : 4-Diaminopteridines as Folinic Acid Antagonists.—Dr. H. O. J. Collier and Margaret Phillips	180
A Chromatographic Method for the Estimation of Oleic and Linoleic Acids in the Presence of Straight-chain Saturated Fatty Acids.—W. Mary L. Crombie, R. Comber and S. G. Boatman	181
Effect of Cortisone on the Neonatal Rat.—Dr. E. J. Field	182
Role of High-molecular Weight Components in the Respiratory Activity of Cell-free Extracts of *Aerobacter aerogenes*.—Dr. A. Tissières	183
Effects of Intraventricular Administration of Substance P.—Prof. U. S. v. Euler and B. Pernow	184
Development of Tolerance to Ganglion Blockade by Methonium Compounds.—Dr. J. K. Mohanty	184
Galactopoietic Action of Thyroxine in Cattle kept in Sub-tropical Countries.—Prof. M. Maqsood	185
Occurrence of *trans*-Acids in Animal Fats.—L. Hartman, Dr. F. B. Shorland and I. R. C. McDonald	185
Relation of Nitrogen Supply to the Molybdenum Requirement of Tomato Plants grown in Sand Culture.—Dr. E. J. Hewitt and Dr. C. C. McCready	186
Copper Sulphate as an Aquatic Herbicide.—Hamid Sharif El Din and K. Wilson Jones	187
Culture of Insect Tissues.—T. D. C. Grace	187
Occurrence of Two East American Species of Crabs in European Waters.—Torben Wolff	188
Modified Horizontal Migration Method in Paper Chromatography.—N. C. Ganguli	189
Staining of Bound Lipids.—M. C. Berenbaum	190
Extension of Range of the Angwantibo.—D. R. Rosevear, C.B.E.	190

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SCIENTIFIC ADVANCES AND INDUSTRIAL DEVELOPMENT

IN an address on science and our industrial future to the Parliamentary and Scientific Committee on May 11, Sir Ben Lockspeiser reviewed some of the ways in which scientific advance has modified profoundly the pattern and character of manufactured goods in international trade. The decline in importance of the older industries in favour of the metal-using industries and those yielding engineering products of a much higher capital value in relation to raw materials used is, he believes, to the advantage of Great Britain. We have the scientific power, the mechanical skill, ingenuity and design ability required; but we can only adapt ourselves to changing conditions by deliberate forethought and concentration of purpose. Sir Ben instanced some of the new opportunities presented to the gas scientists and engineers and in the manufacture of chemicals from oil, as well as in industrial microbiology; but his main stress was laid on the far-reaching consequences which might flow from the applications of the electronic computor in its fully automatic general purpose form. Such machines make considerable demands for the use of scarce and expensive materials such as germanium. A new atomic battery which uses a silicon transistor might be no more than a scientific curiosity; but it could equally prove the first step in the direct conversion of atomic radiation to electrical power.

The full exploitation of transistors, special circuits and electronic innovations generally would no doubt promote the coming of the fully automatic factory. It would also have a profound effect on the development and conservation of natural resources and on human relations in industry. We are, Sir Ben said, within sight of being able to remove the boredom of repetitive routine work, and in the future people may be called upon more and more for creative activity which machines cannot give. This would undoubtedly involve social strains. It could, for example, call for a larger number of highly skilled technicians associated with a comparatively small number of unskilled workers. Already the diminishing differential in pay between skilled and unskilled workers tends to discourage the young worker from serving the years of apprenticeship or training necessary to acquire skill or technique, and the situation envisaged by Sir Ben may well require considerable readjustment of such differentials in pay.

We would require also a much clearer understanding of human behaviour. The Department of Scientific and Industrial Research, said Sir Ben, is already studying the effect of automatic control on human relations in industry, on the skills required and on the problems of management, organization and control, and he referred to an exploratory research project which the Human Relations Committee, established last year jointly by the Department and the Medical Research Council, is sponsoring at the University of Cambridge. This project will cover such matters as the skills required to operate

automatic control techniques, problems of adaptation and re-learning by operators, the attitudes of workers to the changes and the implications for management structure and communication.

Many old conceptions on both sides of industry are still current in Great Britain, although completely out of step with modern technology; a considerable revolution in thought by employers' federations, trade unions, and the nation as a whole must be faced if we are to keep our place as an industrial nation. Scientists may need to broaden their outlook; but we may well advance more quickly in the field of human relations if, to the classical tradition in education, is added a working knowledge of the scientific method, thus enabling more people to bring the rich background of the humanities to the systematic study of human relations. The problem must be tackled realistically, making use of knowledge from the social as well as from the physical sciences.

As Sir Ben pointed out, we cannot expect anybody to invest the large capital required for these new developments without some assurance that they will be operated fully and properly. It is this that gives such importance to the study of the human factors facilitating and restricting the introduction of new production techniques and methods. At the University of Liverpool, for example, the Human Relations Committee is sponsoring an investigation designed to throw light on the factors which tend to facilitate or impede change, the kinds of relationship which tend to promote the absorption of change, and the methods by which change can be absorbed with the minimum disturbance of human relations and welfare. Another study, at the Tavistock Institute of Human Relations, seeks to clarify particularly the way in which technological factors and social or works organizations are related to each other, while a fourth project sponsored by the same Committee at the University of Edinburgh is on the adaptation of the management structure in several Scottish firms to their new activities in the development of electronic equipment, and the adjustment of individuals and groups to new requirements and routines.

The rate of technological innovation is likely to be the most significant factor determining industrial productivity in the future, but the study of human relations is only one of the ways in which technological innovation makes great demands on management. Some of the wider implications have been discussed by Dr. Alexander King, chief scientific officer, Intelligence Division, Department of Scientific and Industrial Research, in a recent article in *The Manager*. Dr. King was concerned with the personal qualities which are needed for wider application of science in industry and the rapid adaptability of industrial design to need and to changing conditions. He recognizes that technological development depends on other factors also, including investment policy and the availability of capital, which are in turn related to the level of taxation and general economic conditions, apart from the psychological conditions under study by the Human Relations Committee and that since established by the Royal Society of Arts, the British Association and the Nuffield Foundation. He insisted, nevertheless, that, at the least, the management of a firm must possess a general background understanding of science and sufficient knowledge of its own expanding technology to enable a balance to be struck between the scientific and economic factors. All major technological development depends on striking such a balance—also, as we are now realizing, on striking it with the social or psychological factors also. There must be, Dr. King says rightly, some point in the councils and management of industry where scientific and technical ideas can be considered with full understanding in making decisions on policy.

Hitherto, admittedly, failure to build a bridge between manager and scientist has been due as frequently to the narrowly specialized attitude of the scientist as to the lack of appreciation of scientific needs by the manager. It is a problem of communication which has been considered at more than one conference organized by the Federation of British Industries in recent years. As yet we know little about the best training for the scientific administrator. The ability to find or select new knowledge, to recognize its significance and the need for change is only one aspect. The manager must also possess sufficient will and initiative to effect the change required, including the persuasion of others, from directors to work-people, to accept the innovation and to co-operate.

As yet we do not really know to what extent the smooth flow of science to industry is blocked by traditional attitudes, bordering upon prejudice, at different levels, or among the workers, nor how far such resistance to change arises from the structure and psychology of the firm or the general thinking of the industry. There are variations in the climate of opinion here, ranging from that current in the family firm, through the large private enterprise to the executive board of a nationalized industry, which may repay study, equally with those rational or irrational factors noted by Dr. King on which managements customarily base their decision to adopt an innovation.

The way in which existing methods of finance stimulate some kinds of innovations and inhibit others, or the extent to which monopoly and free competition, respectively, force or retard the adoption of new methods to the interest of the consumer and the economy, may well involve much more research before decisions are based on knowledge rather than prejudice. The influence of labour costs as an incentive, and the effect of technological change on the general level and distribution of employment are commonly matters of opinion rather than factual inquiry, and there are also such general differences of opinion as that noted by Dr. King in regard to the advantage of being the first in the field with an innovation. In the United States, this is almost axiomatic. In the United Kingdom, on the other hand, it is often held that the first firm to introduce a major innovation bears an undue share of develop-

ment costs which are escaped by competitors who come in later when the change is made and a new market created. Each of these beliefs may or may not be valid in the different circumstances prevailing in the two countries. Clearly it would be of great value to British industry to determine that validity, as would more accurate knowledge of effects of technological innovation on the general level and distribution of unemployment assist in overcoming the opposition of work-people to development, and in reconciling their interests with the increase of productivity and the interest of the community. Nor does the small firm escape such problems. As Dr. King showed, the small firm has advantages as well as disadvantages, compared with the large firm, in applying new knowledge. The one essential need of the small firm is at least one reasonably well-trained technologist to keep in touch with the advances of technology and the best general practice of the industry, and to help put these to productive effect.

Dr. King's paper provides the perspective against which a sounder judgment may be made of some of the projects now being sponsored by the Human Relations Committee with Conditional Aid Funds, particularly those which at first sight might appear to be of dubious value, like the study of the flow of information in industrial organizations. The special reference to the making of decisions relating to production made in this project is liable to give an impression which may well be entirely unjustified.

Both Sir Ben Lockspeiser's address and Dr. King's paper, like the recent inquiry sponsored by the Manchester Joint Research Council, point to the importance of getting more men into the management of British industry competent to meet the scientist and technologist on equal terms, and to assess the scientific and technological factors along with the economic, financial and social factors in development; such men would also be able to see that full use is made both of the results of scientific research and of the opportunities which new scientific techniques, such as operational research, afford in management. Nevertheless, training for management, or the training of the technologist, is only one aspect of the problem. There are personal qualities involved, and perhaps the scientist or technologist will seldom prove to possess administrative gifts of a high order. The more talented he is as an investigator, the more likely his gifts are to find their fullest expression in research and its immediate direction. There are limits also to the use which can be made of such techniques as operational research and improvements in communication.

What needs to be remembered is that there have been changes in the way in which technical innovation works in the British economy, of which the establishment of the National Research Development Corporation in 1949 is one sign. Sir Henry Tizard commented on this in his Messel Memorial Lecture at Aberdeen in 1952, and its implications were discussed in a recent supplement, "Research for Industry", in *The Economist*. Sir Henry judged that Government appropriations supply more money for engineering development than all the engineering industries put together, and the main stimulus to British engineering of the highest quality in recent years has come, he said, from defence research and development rather than from private enterprise. Even then the question could be asked whether the taxpayer would in future have to undertake the risks which formerly were taken by private enterprise. Sir Henry said frankly that he was not happy at the principle behind the National Research Development Corporation, and he did not like to think that the leaders of British industry were becoming less adventurous.

Something more than research on the factors affecting the speed at which technological innovation proceeds is required to answer the questions which the growing dependence of research upon government support raises. Those questions are a matter of concern in the United States quite as much as in the United Kingdom; nor should it be assumed that the balance between public and independent or private support should be the same in both countries, still less that the balance between applied and fundamental research should be the same. It may well be true that, as *The Economist* suggests, Britain should be devoting a much greater proportional effort to research than the United States. It may also be true that the proportion devoted here to applied research and development requires to be increased relative to that devoted to fundamental research. The major issue to be raised first, however, is whether the direction of our research effort, as well as its distribution, is likely to be wise if it continues to be financed so preponderantly from government sources.

Admittedly, in such new fields as atomic energy the main research effort for some time to come is likely to remain entirely under State control; but with the Ministries most concerned with research and development almost trebling their expenditure in the past four years, there is, in the first place, some risk that the continuance of such dependence on State support may warp the direction of research effort away from the lines that ordinary economic demand would indicate. It is no answer to point out that defence research may and does assist in the commercial development of some valuable technical innovations. The price which has to be paid in the retardation of technical progress elsewhere for the civil developments which defence research brings in its train should be remembered. Often it cannot be estimated, particularly if we think in terms not of money or materials, but of the even scarcer factor—outstanding scientists.

The second factor which Sir Henry Tizard had chiefly in mind is even more important. Can we rely on a government department to select the right targets and to take the risks inherent in technological development as wisely and as boldly as the individual entrepreneur? Arguments advanced in the debates on the Atomic Energy Authority Bill should give pause to any such thinking. The weakness, if not

fallacy, of any such assumption was demonstrated in a pamphlet, "The Chemical Industry and Challenge to Britain", issued by Imperial Chemical Industries, Ltd., last February for the information of stockholders and employees. If British industry is defective in initiative, in enterprise or in judgment, its weaknesses are unlikely to be rectified from without the industry by any public body.

This is not to say that the National Research Development Corporation will not perform useful functions, or that self-financing and institutional investment will not promote as many risks as saving by the individual investor. But they may not, and if Britain is to devote the maximum share of her industrial resources to research, and if her present industrial economy is to be as effective in promoting technical advances as those out of which it has emerged, it would be prudent to see that individual initiative and originality have their opportunity to contribute to the scientific industries of the future. Moreover if, as the investigators of the Manchester Joint Research Council found, the personalities of directors and managers at the highest level in a firm and the attitudes to the scientific approach to production are the dominating factor determining the use of new knowledge or the adoption of new ideas, the decisive factor will be the industrial and social climate of opinion which the late Dr. K. T. Compton stressed in his address to the Parliamentary and Scientific Committee last February.

In forming such a climate of opinion in which technological progress and productivity thrive, education, and especially higher technological education, as Dr. Compton pointed out, is of far-reaching importance. More light on the factors which assist or retard the adoption of technological innovation in industry will be welcome, and it is possible that some of the investigations already in progress in this field may yield results which will enable measures for the encouragement of enterprise and originality, or the removal of hindrances to change, to be based on factual knowledge rather than on political theory or prejudice. The essential task, however, is that of education, and education at all levels affecting the climate of opinion within which the scientist and technologist work. If by the expansion of higher technological education and the broadening of the content of education, not only of the scientist and technologist but equally of the administrator, the industrialist, the manager and the trade unionist, we encourage the development of such a climate of opinion that the implications of technological change for Britain's industrial and economic future are clearly understood, it will become relatively less important whence the main support for research is derived. The direction of research and the application of its results are likely to lie, in that event, in the hands of those competent to appreciate the significance of new discoveries, to evaluate the complex scientific, technical, economic and social factors involved and to secure the co-operation of all concerned in and affected by the technological changes they initiate.

LYSENKO IN PERSPECTIVE

Agrobiology

Essays on Problems of Genetics, Plant Breeding and Seed Growing. By T. D. Lysenko. (Translated from the Fourth Russian edition.) Pp. 636+12 plates. (Moscow: Foreign Languages Publishing House; London: Collet's Holdings, Ltd., 1954.) 15*s*.

BRITISH research workers regard polemical papers with suspicion, not to say distaste. This circumstance has engendered among us a delicate art of scientific (as distinct from literary) criticism. A critic is permitted to demonstrate that his colleague's facts are incorrect. He can go further and demonstrate that his colleague's hypotheses are inconsistent with the facts. But he cannot with propriety go further still and impute motives or reasons for his colleague's inaccuracies: as that his technique was sloppy, or that his ambition drove him to publish prematurely, or that his political views coloured his writing, or simply that he is a liar. Therefore we would not expect to read in the *Annals of Botany* a passage like the following: "Why has . . . one of our outstanding biologists fallen into error in his work on mutation of species? . . . Because he has departed from the principles of Darwinism . . . [and because his] statements have not been subjected to the appropriate comradely criticism without which, as our teacher Stalin points out, science cannot advance".

This quotation is from the *Botanicheski Zhurnal* (Botanical Journal) for December 1952. The writer is a *bona fide* botanist and the outstanding biologist he refers to is T. D. Lysenko. British scientific journals would not be likely to accept such a passage as this, even if it were about Lysenko, and it is important to remember this difference in intellectual climate when we discuss Soviet science. Of course, the Russians publish scores of papers which are as objective and impersonal as the papers in British journals. But when they do descend to scandal they do so unambiguously and in public.

This much understanding of the Russian temperament is a prerequisite for reading the recently translated volume of Lysenko's collected essays on agrobiology. If the British reader approaches it as he would (for example) a volume of essays from Rothamsted he will be nauseated. If he approaches it to gain an understanding not of agrobiology but of Lysenko's career he will be deeply interested. For this book contains some of the data necessary for an understanding of the recent history of biology in the U.S.S.R.

It begins with two essays on phasic development in plants, published nineteen years ago. Lysenko had stumbled upon the discovery made by Gassner in 1918 that certain plants ripen earlier if subjected to a cold period, and he spent some years unsuccessfully trying to apply Gassner's technique on a commercial scale. These early essays, though tedious and unconvincing, do make some pretence of recording and interpreting observations. Their obvious intention is not to advance science but to apply science to agriculture. It has to be remembered that while Lysenko was working on phasic development Russia was passing through a terrible crisis. Compulsory collectivization of farms had brought about a collapse of food production, and millions were dying of starvation. It is therefore not surprising that Lysenko's work was tendentious.

There follow in "Agrobiology" half a dozen essays which are little more than harangues to collective farmers. For Lysenko had discovered his flair. He had an uncanny power of persuading peasants to adopt better methods of husbandry and to take a pride in increasing yields; and that was what Russia needed twenty years ago: not so much more science in farming, but simply more common sense in farming. In fulfilling this need Lysenko was notably successful.

His success brought him into conflict with the genuine biologists of Russia for two reasons. First, he sincerely imagined that his successes as a propagandist for better farming were due to his ideas about biology, for he was not content with a pragmatic approach to crop yields: he had to rationalize his methods with the pseudo-philosophical theories of men like Michurin. This he tried to do in a series of violently polemical papers (1937–48), many of which are reproduced in this book. His train of thought was transparently tendentious. "If," he says (p. 230), "I have made a trenchant assault on Mendel's law . . . it is primarily because this law greatly hinders me in my work." Secondly, he sincerely imagined that the failure of other Russian biologists to improve the efficiency of agriculture was due to their preoccupation with fruitless scientific problems and fundamentally unsound theories. The natural reaction of Russian biologists was to ignore Lysenko and his colleagues as troublesome cranks; and this they did successfully until 1948. In that year the State made the decision to give Lysenko official support, and his powerful adversaries were driven into obscurity. It is a mistake to suppose that any reputable Russian scientist was under the impression that Lysenko had made any major discovery. It was a temporary triumph of expediency over truth. As Zhukovsky said at the time, it is important "at this juncture to cherish the prestige" of Lysenko.

"Agrobiology" reproduces in full Lysenko's speech to the Academy of Agricultural Sciences on this melancholy occasion in 1948. There follow a series of essays in which Lysenko's ideas, now free from public criticism, undergo an unrestrained proliferation. He claims to have produced, by manipulating the environment, soft wheats from hard wheats and rye from wheat. He writes less agricultural propaganda and more woolly theory. Apart from advocating the sowing of forest belts on hills, he has little to say which is likely to catch the imagination of the peasant. His articles, notably one (p. 582) published in 1952 for the "Soviet Encyclopedia", become more speculative and more fantastic. Meanwhile, Russian agriculture has again entered upon a crisis, and N. S. Khrushchev, first secretary of the Central Committee of the Party, initiated in 1953 a new set of reforms on collective farms. He heavily criticized the previous policy of the Ministry of Agriculture, and it seems as though he is now willing to charge Lysenko with the very sort of inefficacy with which Lysenko charged his critics in 1948. For on March 29, 1954, the official journal of the Communist Party published the following statement: "The monopolisation of science leads . . . to the cutting off of people who do not think on orthodox lines, and living scientific thought is stifled. This has been shown, for instance, in the All Union Academy of Agricultural Sciences".

Lysenko is still director of this Academy. For a time, and probably due to the critical condition of Soviet agriculture, the Russian Government backed a man who would otherwise have sunk into the scientific obscurity he deserves. His book of essays is a warning against confusing science with practice; and it now seems that it may mark the end of a deplorable incident in the history of scientific thought.

E. Ashby

THE RISE OF EVOLUTIONARY CONCEPTS

Evolution

Die Geschichte ihrer Probleme und Erkenntnisse. Von Dr. Walter Zimmermann. Pp. ix + 624 + 8 plates. (Freiburg–München: Verlag Karl Alber, 1953.) 32 D. marks.

THE author of this book, Dr. W. Zimmermann, aims at providing a detailed historical survey of the gradual emergence of the concept of evolution in plants and animals and of the progressive realization of the problems it presents. It is divided into three parts. The first, entitled "Doctrines of Descent, without a Scientific Foundation" (Abstammungslehren ohne Abstammungswissenschaften), embraces the ancient period up to the Middle Ages and is largely concerned with a consideration of the attitude of the Greek and Roman philosophers. The second part, "Evolutionary Science without Evolutionary Doctrines" (Abstammungswissenschaften ohne Abstammungslehren), covering the period from the Renaissance to the eighteenth century, is mainly devoted to the role of such pioneers of classification as Cæsalpinius, Ray, Linnæus, etc., but also includes sections on the development of the scientific method (Bacon, Descartes, Spinoza, Leibniz and others) and on the commencing realization of the meaning of fossils. The third part, covering recent times, the "Period of Conscious Evolutionary Science" (Zeit der bewussten Abstammungswissenschaften), deals successively with the pre-Darwinian period (Lamarck, St. Hilaire, Oken, A. Braun), Charles Darwin, and the post-Darwinian period; under the latter heading are included sections dealing with the return to the idealistic point of view (Troll), the rate and causes of evolution (viruses), the biogenetic law, speciation, etc. Such an outline gives but a bare indication of the many aspects of biological science taken into consideration and of the innumerable authorities whose attitude and contribution are evaluated.

The method of treatment is peculiar, since much of the book is occupied by frequently lengthy quotations from various sources, for the most part citations (in German) from the particular authority momentarily under discussion. These are interspersed with often quite brief passages (printed in smaller type) in the author's own words, which serve as commentaries and to link together the matter in successive quotations. This, combined with the division of the subject-matter into numerous sections and subsections, gives a somewhat disjointed character to the whole presentation, and one is inclined to wonder whether a less fully authenticated account would not have resulted in an equally valuable and shorter, but more readable, version. The disadvantage of this dissection makes itself specially felt when the author is tracing the progressive steps in interpretation arrived at by such pioneers as Goethe and A. P. de Candolle, the protagonists of comparative morphology, or, in other

domains, of such men as Linnæus and Darwin. There is no doubt that Dr. Zimmermann brings out successfully the gradual development in Darwin's mind of the theory of descent and of the struggle for existence; but could it not have been done more smoothly and just as convincingly in a more connected narrative and in less than twenty-three pages?

On the whole, that dealing with the post-Darwinian period is the least impressive part of the book. Referring, as it must, to almost every aspect of biological science, it is too much crowded with detail to give that broad conception of the forward march during this modern era that would have been specially valuable.

F. E. Fritsch

PROGRESS IN NUCLEAR PHYSICS

Progress in Nuclear Physics

Vol. 2. Editor: O. R. Frisch. (Progress Series.) Pp. viii+295. (London: Pergamon Press, Ltd., 1952.) 63*s*. net.

THE second volume of "Progress in Nuclear Physics" contains an authoritative series of articles on the electron optical properties of magnetic beta-ray spectrometers, by N. F. Verster; nuclear paramagnetic resonance, by R. V. Pound; luminescent materials for scintillation counters, by G. F. J. Garlick; the neutron–proton interaction, by G. L. Squires; nuclear fission, by W. J. Whitehouse; the low-lying excited states of light nuclei, by W. E. Burcham; the nuclear shell model, by B. H. Flowers; and ionization by fast particles, by T. E. Cranshaw. These articles are well written by leading workers in their respective fields.

The review by R. V. Pound describes the magnetic resonance experimental methods for measuring nuclear magnetic moments, the interaction of nuclear moments with the surrounding media and the g-values describing the relation between magnetic moments and cylinder momentum. An account is given of the theory of these phenomena.

The scintillation counter has now become one of the most widely used tools of nuclear physics, and Mr. Garlick's review gives an account of their construction and application to the detection of neutrons, cosmic-ray particles, fission fragments, gamma-ray energies and X-rays.

The interaction of the neutron and proton is determined by the all-important nuclear forces. Mr. Squires gives a good account of the contribution of experiments on the scattering of neutrons by protons, protons by protons and the photo-disintegration of the deuteron to the study of this interaction. The experimental data are not yet good enough to come to any firm conclusion about the potentials describing the interaction, and this subject is still being pursued energetically by most laboratories equipped with large cyclotrons.

A vast amount of data has been published since the Second World War on the important subject of nuclear fission, and Mr. Whitehouse's review is very useful and timely in bringing all this together. A brief account of the theory of fission and the experimental techniques is followed by experimental data on fission cross-sections and thresholds; fission yields for particles of different energies; and studies of the energy distribution and properties of fission fragments. An account is also given of the phenomenon of delayed neutron emission, which is so important to reactor design and spontaneous fission-rates.

Prof. Burcham gives a brief theoretical description of nuclear spectra in the light elements in terms of the characteristic of nuclear forces. A brief account of the experimental methods used in low-energy nuclear physics is followed by an account of important experimental phenomena such as the energy-levels of mirror nuclei and their interpretation in terms of spin and parity.

Mr. Flowers gives an account of the evidence for the shell model in terms of spin-orbit forces. Mr. Cranshaw describes the theory of loss of energy by ionization of high-energy particles and compares this with experiments with cosmic-ray particles.

J. D. Cockcroft

SUGAR TECHNOLOGY

Principles of Sugar Technology

Edited by Pieter Honig. Pp. xxii+767. (Amsterdam and New York: Elsevier Publishing Company, Inc.; London: Cleaver-Hume Press, Ltd., 1953.) 95*s*.

MANY up-to-date handbooks on sugar technology already exist which might be supposed to cover the needs of the sugar industry, but the one now under review fills a new niche. The editor, Dr. Pieter Honig, at present research director to the West Indies Sugar Corporation of New York, is rather better known for his earlier work at the renowned Proefstation voor de Java Suikerindustrie (Java Sugar Experimental Station), Pasuruan. He has enlisted the assistance of some former colleagues and a number of other leading authorities to write the eighteen chapters of this volume. The endeavour has been made to link physical and chemical properties of sucrose, reducing sugars and non-sugars with the processes involved in sugar manufacture and to assess the degree to which theory underlies actual practice. A second volume is proposed which will be concerned with evaporation, crystallization, heat transfer, drying and cooling. The volume is divided into Part 1, which deals more with chemistry and physics, and Part 2, which is concerned with purification of sugar solutions.

Taking these in reverse order, for the latter part is of direct practical importance, it can be said that the three chapters on clarification (chemical technology, fundamental reactions and process technology) are uniformly of high standard, and the references in the bibliography at the end of the chapters, as is the case throughout the volume, are extensive and well up to date. Some overlapping occurs, as is usual with a number of authors. The succeeding chapters deal with sulphitation, carbonatation (by Dr. Honig), middle juice carbonatation and ion exchange, and are also to be commended.

Part 1 is open to some criticism; it includes matter which could well have been omitted. For example, in Chapter 2 the tables of physical constants occupy about 42 out of 52 pages and are already available in standard text-books—Spencer-Meade, Brown and Zerban, Circular *C*.440 of the National Bureau of Standards. The physical properties of sucrose are given in bare detail without much discussion of their significance, and the subject of optical rotation is discussed in one page. No reference is made to the recent work on solubility of sucrose by

M. Taylor. Activity coefficients are not defined; those quoted of Downes and Perman (1928) have been totally superseded by the far more accurate work of Scatchard (1938). The value quoted for the thermal conductivity of packed granulated sugar is undoubtedly too low and approximates more nearly to that given for raw sugar. The chapter generally lacks co-ordination, being just a compilation of isolated facts and figures. It does serve, however, to emphasize the lack of existence of much correlated data on the physical properties of sucrose and the need for more concerted effort in this field. The physical and chemical properties of reducing sugars comprise a well-written chapter that is marred by inclusion of methods of analysis already mainly found in well-known works of reference. Other chapters of real merit have some shortcomings. Some subjects are not discussed at a length commensurate with a volume of this size: for example, kestose, bone charcoal and sugar salt complexes in relation to molasses formation. The described preparation of pure sucrose is out-dated, and later, more suitable methods are ignored. It is doubtful whether, in fact, pure sucrose can be prepared by recrystallization of beet sugar without some contamination with raffinose.

Chapter 11, with its curious title, is nevertheless a clear and enlightening account of a difficult subject. It might have given greater stress to the necessity for glass electrode systems in process control and should have mentioned the more accurate *p*H of buffer solutions at elevated temperatures, published by the National Bureau of Standards, Washington, D.C.; also, a more recent book than Dole's is that of L. Kratz, namely, "The Glass Electrode and its Applications".

Chapters on non-nitrogenous acids as well as amino-acids are a useful inclusion, there being no other comprehensive up-to-date collection of data. Chromatographic analysis for the latter has been well covered, but one is puzzled at the absence of chromatographic examination of sugars and derivatives. One must, however, be grateful for small mercies, and there is no doubt that Honig's information is by no means small. So much useful material has been collected, screened and discussed, together with multitudinous references, that no progressive sugar company can afford to neglect this volume; and even the sugar beet industry, which has not had special attention by Dr. Honig and his colleagues, will find much of interest and importance in its pages.

H. C. S. DE WHALLEY

BRITISH MEDUSAE

The Medusae of the British Isles

Anthomedusae, Leptomedusae, Limnomedusae, Trachymedusae and Narcomedusae. By Frederick Stratten Russell. (E. T. Browne Monograph of the Marine Biological Association of the United Kingdom.) Pp. xiii + 530 + 35 plates. (Cambridge: At the University Press, 1953.) £6 10*s*. net.

THIS very fine book is not only an outstanding monograph on an animal group and a monument to the skill and energy of Mr. F. S. Russell, but is also a beautiful thing to have and possess; apart from its serious scientific merits, it has a good deal of entertainment value. This will not have been lost on the author himself. It is the persons (not to say personalities) of the medusae and polyps which lend themselves to this effect: not only are their figures often elegant, but their postures are frequently lively, comic or grotesque, their tentacles and other parts are waved or brandished with decorative or dramatic insistence, and sometimes assume the semblance of the arms and legs of humanity (see, for example, Figs. 255–6). Thus the volume is full of Russian ballet *décor* and has also its moments of comic relief, as in the clog-dancer of Fig. 211, who is misleadingly described as a "portion of umbrella margin". Here and there the text achieves the same result, where Mr. Russell quotes from an earlier author (as on p. 88, from Forbes, 1848) who uses a descriptive language more vivid than is customary in scientific works of the present day. To return to Mr. Russell's skill and industry, he has illustrated the volume by 319 text figures and 35 plates, the drawings for which were made by himself except where otherwise stated. Among the figures he has included not only many showing the elegancies of living polyps and medusae, but also others giving the appearance of preserved material—very different in its crumpled aspect from that of the live animals, but the more useful for identification in that many collections of planktonic species have to be named from preserved specimens. An interesting and ingenious feature is the introduction of a very effective pictorial key to the British species. A small diagrammatic figure of each is given, and the figures are so arranged as to make preliminary identification practicable not only more quickly but also with less possibility of error than would be the case with a verbal key. The thirty-five plates are reproduced, in the main, from exquisitely delicate coloured drawings by the author. These have been excellently reproduced on pleasing paper, but it is unfortunate that the caption for each plate has been printed in black on the back of its predecessor, so that it shows through the paper slightly and mars the perfection of the preceding plate.

The text begins with an introduction, which is followed by a clear account of the structural features of medusae, including a section on their nematocysts. The next sections deal with life-histories and distribution, the rearing of hydroids and medusae, collection and preservation, with a subject index to the literature. There follow a note on the identification of medusae, and the pictorial key already mentioned. After this begins the main part of the book, which is occupied by descriptions of the British species. These attain the high level to be expected of Mr. Russell, and include notes on distribution, developmental stages, nematocysts, seasonal occurrence and habits, as well as the customary details of structure and history. Finally, there are appendixes and a thirty-page bibliography.

The publication of this book, which has naturally been very expensive to produce, was made possible in the first place by a bequest to the Marine Biological Association from that well-known student of the medusae, Mr. E. T. Browne, who first stimulated Mr. Russell's interest in the group. This initial bequest was supplemented by grants from the Browne Fund of the Royal Society and from the Syndics of the Cambridge University Press. As it is now more than a hundred years since Edward Forbes's "Monograph of the British Naked-eyed Medusae" appeared (in 1848), the publication of a new and much fuller account has been greatly needed. Its achievement in this majestic form redounds greatly to the credit of Mr. Russell, Mr. Browne and the Cambridge University Press.

T. A. STEPHENSON

Onoranze a Leonardo Da Vinci nel Quinto Centenario della Nascita—Comitato Nazionale

Nr. 1: Leonardo Da Vinci: la Vita. Da Titina Strano. Pp. 84+9 plates. Nr. 2: l'Ingegneria Militare di Leonardo. Da Ignazio Calvi. Pp. 40+24 plates. Nr. 3: la Visione Scientifica di Leonardo Da Vinci. Da Carlo Zammattio. Pp. 46. Nr. 4: le Armi di Leonardo Da Vinci. Da Luigi Tursini. Pp. 14+13 plates. Nr. 5: la Botanica nel Pensiero di Leonardo. Da Alessandro Bazardi. Pp. 40+17 plates. Nr. 6: Geografia e Geologia negli Scritti di Leonardo Da Vinci. Da Agostino Gianotti. Pp. 48+7 plates. Nr. 7: Leonardo Da Vinci e la Meccanica Tessile. Da Giovanni Strobino. Pp. 100. Nr. 8: l'Anatomia e la Fisiologia di Leonardo Da Vinci. Da Mario Senaldi. Pp. 64 (24 plates). Nr. 9: Programma e Idealità del Museo Nazionale della Scienza e della Tecnica "Leonardo Da Vinci". Da Guido Ucelli. Pp. 102 (45 plates). Nr. 10: Vinci Leonardo e la sua Famiglia. Da Renzo Cianchi. Pp. 106 (22 plates). Nr. 11: Leonardo Architetto e Urbanista. Da G. U. Arata. Pp. 182+6 plates. Nr. 12: il Pensiero Estetico di Leonardo Da Vinci. Pp. 30. (Milano: Museo Nazionale della Scienza e della Tecnica.)

TO readers of *Nature* the value of eleven monographs on the life and achievements of Leonardo da Vinci is limited by their being written in Italian and the fact that only Nos. 5, 7, 8 and 11 contain bibliographies. All but Nos. 3 and 12 are profusely illustrated, many of the pictures being of the lavishly produced models sponsored by the Italian Government before the Second World War and now re-built to furnish the Italian National Science Museum in Milan (see *Nature*, **172**, 377; 1953). Others among the illustrations will be familiar to those who visited the Royal Academy exhibition in London last year, and it is particularly interesting to note the way in which Leonardo's scientific methods of observation illumine his artistic work on physiology, botany, geology and geography. The range of his interests is astonishing, but there is still doubt as to how far his recordings were of his own original devices and, if so, how far they actually influenced future developments. Pamphlet No. 7 on textile machinery traces devices similar to Leonardo's right down to those in modern machines. Less than justice is done to his work on aeronautics in this series, although it is probably true to say that no evidence exists to show that he had the slightest influence on the future, and some of his ideas were fundamentally unsound. Pamphlet No. 9 is largely an illustrated account of science museums in other countries designed to stimulate Italian interest in the Museum newly raised to Leonardo's honour in Milan.

Physics

By Prof. Noel C. Little. Pp. viii+648. (Boston: D. C. Heath and Company; London: George G. Harrap and Co., Ltd., 1953.) 35*s*.

THIS course represents a decided break from the traditional approach to physics, for it is organized around five fundamental concepts and five types of phenomena. Thus the watertight compartments of heat, light and so on have been broken down, and the subject is presented as a unified whole. Now all will agree that this method has undoubted merits; but the real test of its efficacy is whether it will be more beneficial to students than the more orthodox teaching. Apparently the author and his colleagues have used the course for many years and are satisfied with the results; so far as British schools are concerned, one feels that it would probably take a long time to establish such a departure from the orthodox method, whether desirable or not.

For an elementary text tradition has again been broken by the use of the M.K.S. system (probably the most useful) rather than the C.G.S. system of units, while the British units are confined to the gravitational system; it will come as a shock to the uninitiated student that the unit of force is the 'newton', not the 'dyne'.

The course is evidently well planned and excellently presented; the mathematics involved is quite simple, and many typical questions are worked out in the text. It is sad, however, to find that the term 'electromotance' supersedes our old friend 'electromotive force'; in spite of this, though, one suspects that students and engineers will continue to speak of 'e.m.f.'.

Geometrical Optics

By Dr. C. Curry. Pp. viii+173. (London: Edward Arnold and Co., 1953.) 21*s*. net.

ALTHOUGH the reviewer is not wholly satisfied that it is necessary or desirable to devote a separate book to geometrical optics at this stage of the work, yet the author, Dr. C. Curry, as a result of his experience, is undoubtedly convinced that such a book is necessary. His aim is to give a balanced account of the subject suitable for students in the two years before a degree examination, at the same time keeping in view the underlying physical principles and the ultimate application to optical instruments and their design.

It must be said at once that Dr. Curry has achieved his aim very satisfactorily, and he has studiously avoided the temptation to lengthen the book by developing certain sections to a more advanced level. The explanations are very clear and easily followed, and if any section can be singled out it is that on the aberration of optical systems, which is particularly well done.

Certain departures from the usual nomenclature have been made. For example, μ is used exclusively for relative refractive index, while the time-honoured u and v for object and image distances have disappeared. The so-called new Cartesian sign convention is used as being most in line with advanced optical practice, and in this connexion dare we hope that one day just one convention will be adopted for universal use?

River Purification

A Legal and Scientific Review of the Last 100 Years. By F. T. K. Pentelow. (Being the Buckland Lectures for 1952.) Pp. viii+63. (London: Edward Arnold and Co., Ltd., 1953.) 5*s*. net.

THIS small volume contains the text of the three Buckland Lectures for 1952, which were delivered by F. T. K. Pentelow, chief inspector of salmon and freshwater fisheries in the Fisheries Department of the Ministry of Agriculture and Fisheries. The first lecture—on the development of the law affecting pollution of rivers—is an admirable summary, with a useful bibliography of Acts of Parliament. The remaining two lectures deal with the effect of pollution on streams and with methods of treating waste waters; they are necessarily brief, are addressed primarily to river authorities concerned with freshwater fisheries, and give a sound account of the elements of the subject.

B. A. S.

THE REOPENING OF PULKOVO OBSERVATORY

IN 1835, F. G. W. Struve was commanded by the Emperor Nicholas to superintend the erection, without regard to expense, of an astronomical observatory at Pulkovo on the summit of the low hills some eleven miles south of St. Petersburg. A broad highway already led due south (actually it is a degree away from the true meridian) from the Admiralty spire in the centre of the city, and the site chosen was on the line of this road. The Observatory, which "was acknowledged to surpass all others of its kind in splendour, efficiency and completeness", was opened in August 1839 with Struve as director. The renown of the Observatory mainly rests on the incomparable series of meridian observations, made with great skill and care, without interruption and with the same instruments—a transit telescope for right ascensions and a vertical circle for declinations. The value of these observations to positional astronomy is very great. But its fame also rests on a broader basis, especially in later years.

Pulkovo Observatory maintained its standing through the Revolution of 1917, and its traditional work on fundamental astronomy was continued on a high level until the Second World War. During the siege of Leningrad in 1942, the Observatory was in the direct line of fire, and its site, commanding the plane of the city and clearly of military importance, was occupied by the enemy. The buildings were completely destroyed, but the smaller instruments, the optical parts of the larger instruments and the more valuable records and books (including the Kepler manuscripts) were moved to safety; among other losses the mounting of the 30-in. refractor was demolished. At the end of the War the Observatory lay in ruins.

The rebuilt and re-equipped Central Observatory of the Academy of Sciences of the U.S.S.R. at Pulkovo (Fig. 1) was formally inaugurated on May 20–22 in the presence of some five hundred astronomers and scientists, including representatives from most countries from China to the United States. The inaugural address was given on the evening of May 20 in the hall of the Academy of Sciences in Leningrad by Academician Bardin, acting on behalf of the president of the Academy, who was ill. On the following day he declared the Observatory open by formally cutting the tape at the entrance to the main building; this ceremony was followed by the presentation of congratulatory addresses and a general inspection of the Observatory. Many of the addresses were in elaborate

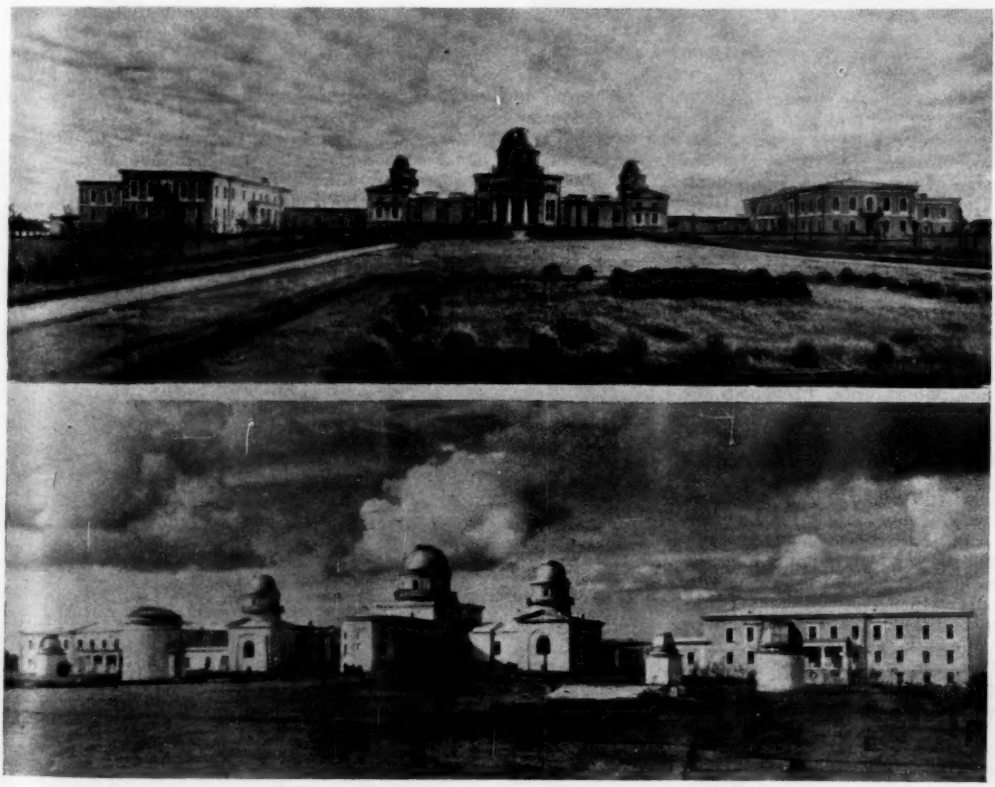

Fig. 1. General views of Pulkovo Observatory: above, from the north; below, from the south

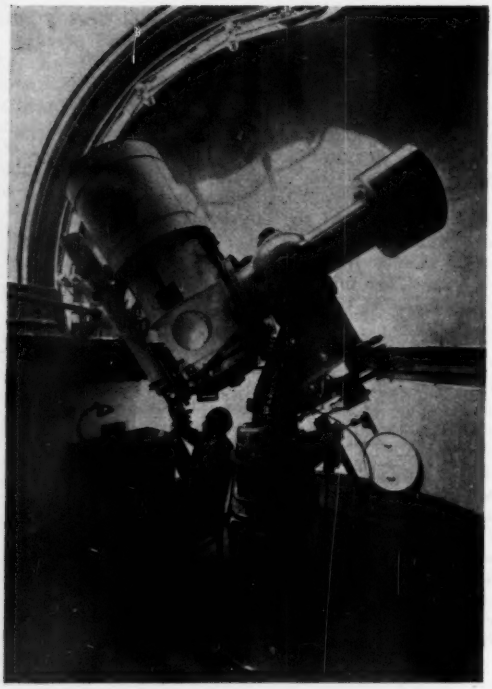

Fig. 2. The Maksutov meniscus telescope. The ultra-violet spectrograph is designed for attachment at the end of the polar axis

bindings, and the Chinese delegation presented a magnificent red and gold silk banner. The following day was devoted to a series of papers describing the work of the Observatory by the astronomers in charge of the different departments.

The main building of the Observatory has been rebuilt exactly as it was (even to the date 1839 over the main entrance), thus preserving the well-known silhouette of the three domes (actually they were turrets in the old building), which is such a fine landmark as seen from Leningrad. But two large wings have been added, containing offices, laboratories, residences for the director and senior staff, and a magnificent conference room; seating more than 250 in tip-up chairs, panelled in marble, with fine curtains, with cinema projectors and screens, it must surely be the finest in any observatory.

In the central building are the two famous old meridian instruments of 1839, restored and in working condition, side by side with new instruments. One of these is a mirror transit in which star passages are observed through fixed north–south telescopes by reflexion from a steel mirror, which is the only moving part; the results are encouraging. At present the three domes contain only minor instruments or are awaiting new ones.

However, there are some twenty other groups of buildings and domes, a few still in course of erection. The larger buildings comprise a hotel which can accommodate fifty students or guests, living quarters for the staff, and a hostel for junior staff; there is even a kindergarten. Some of the domes and pavilions contain the pre-war instruments, such as the 7-in. meridian circle (1914), the astrographs and the vertical telescope; but there are four or five entirely new instruments. Perhaps the most interesting is the 500-mm. Maksutov meniscus telescope (Fig. 2), designed for use with a spectroscope in the ultra-violet; it appears to have been built entirely in the Soviet Union.

Another remarkable instrument is a polar telescope designed by the director, Prof. A. A. Mikhailov. It must be one of the few telescopes with which observations are made through a glass window; this allows the whole building to be thermally insulated. The instrument is operated by remote control, so that the observer need not enter the building during the night's observation. Careful measurements show that, by excluding the body-heat of the observer, internal refractions in the telescope tube are substantially reduced; there is a still further reduction when the building is left sealed for several days. For simplicity the plate is fixed, and exposures are made by means of a rotating shutter in front of the object glass; the position of the pole is therefore determined on each plate from a series of short arcs for each of four or five stars. The interesting feature is that the Loomis telescope at Yale, adapted for precisely the same programmes, uses an entirely different design: the long tube is open to the outside air, and the plate rotates to counteract the earth's rotation. The eventual comparison of results from the two instruments will indicate which choice of desirable and undesirable factors is the better.

A rather revolutionary instrument is an interferometer (looking like a range-finder) designed by Academician Linnik for observing, with extreme accuracy, the horizontal component of the separation of double-stars (see Fig. 3). By observing at different

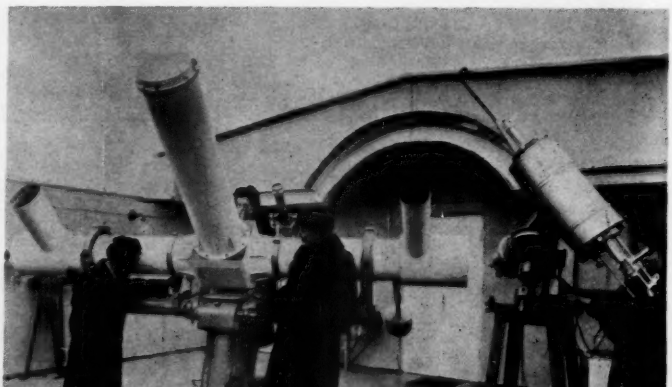

Fig. 3. The Linnik interferometer for measuring the separation of double stars. Academician Linnik is in the centre of the picture

hour angles, the actual separation and position angles can thus be calculated.

The horizontal solar telescope with its several different spectrographs is apparently giving good results, due mainly (according to Prof. Krat) to the excellent definition which is a feature of Pulkovo during the early summer. Some of the direct photographs, on a scale of 56 cm. for the sun's diameter, show remarkable surface detail and solar granulation, with individual granules about 0·4″ in diameter.

It has been decided not to remount the 30-in. object glass, and a new 32-in. objective has been constructed in Leningrad; a mounting is being designed.

It is impossible to assess the merit of an observatory, especially one of which the main work is astrometric, from a superficial tour of inspection. To British ideas some of the building work (largely done by women) is rather poor and some of the equipment rather naïve. But the general impression is that Pulkovo is a fine observatory, with a wide range of instruments, and, above all, with a first-class staff under the direction of an astronomer who commands world-wide respect; there seems every prospect that Pulkovo will attain the eminence in the future that it has so justly been accorded in the past.

This account would not be complete without recording that the rebuilding of Pulkovo is but one of the many evidences of great astronomical activity in the Soviet Union. For example, the Sternberg Institute and Observatory of the University of Moscow are being rebuilt on a grand scale on the Lenin Hills, in the shadow (as it were) of the towering new university buildings; but the main observing station will be some twenty-five miles south of Moscow. The opening ceremonies were followed by two conferences—one on astrometry and the other on variable stars—both of which were the eleventh of a regular series organized by the Astronomical Council of the Academy of Sciences. The numbers present at these conferences and the reports from the different observatories confirmed the increasing interest in astronomy. Other evidence is the great number of text-books, at all levels, being produced: some are extremely good.

There is not, and perhaps has never been, any doubt as to the genuine desire of the Soviet astronomers themselves to co-operate with those of other countries; the personal contacts at Pulkovo reaffirmed this, and it is greatly to be hoped that freer intercourse will be possible.

The astronomers from the Western countries (two American, one Canadian, two British, two French, one Belgian, two Dutch, one Norwegian, one Swedish and one Italian) are most grateful to the Soviet Academy of Sciences for making possible this meeting with their colleagues in the U.S.S.R., and for its most generous and comprehensive hospitality both in Leningrad and later in Moscow.

D. H. Sadler

A GREAT HAUL OF AMBERGRIS

By ROBERT CLARKE

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DURING the last Antarctic whaling season a boulder of ambergris weighing 926 lb. was found in the large intestine of a bull sperm whale (Fig. 1). The whale, which was 49 ft. long, was being worked up on board the floating factory *Southern Harvester* on December 21, 1953, in 58° 23′ S., 14° 13′ W.

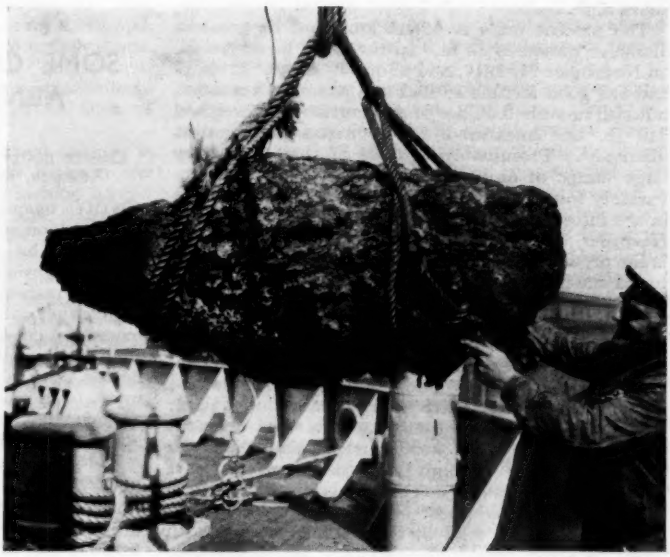

Fig. 1. Ambergris weighing 926 lb. taken from a sperm whale in the Antarctic on December 21, 1953. (*Photo by courtesy of Messrs. Chr. Salvesen and Co.*)

Although this boulder is no doubt the largest single mass to be properly examined and authenticated, the figure of 926 lb. is actually exceeded by four others in the literature. However, when these figures are examined, at least three of them do not necessarily refer to a single mass from one whale: the largest figure is to be found in *The Times* of December 15, 1947, which printed a report that the Brazilian steamer *Araxa* chanced upon ten tons of ambergris at sea. This was described as a "gray, odoriferous mass"; but it is not conceivable that such a quantity could have come from one whale, and, if the substance was ambergris and its weight not exaggerated, then it could only have been an extraordinary drift of numerous lumps of flotsam ambergris close together. The other three figures are more reasonable when judged by the present haul. 983 lb. of ambergris were entered in the manifest of the whaling bark *Splendid* of Dunedin, New Zealand, in 1883[1]; but this was a production figure at the end of a whaling voyage and so may have included ambergris from more than one whale. The Portuguese Fisheries Statistics record 928 lb. (422 kgm.) from San Miguel, Azores, in 1944; but this may have comprised a lump of 708 lb. (322 kgm.) plus one or more smaller finds[2]. The only figure, in fact, which specifically refers to a single mass of ambergris greater than the present haul is one of 982 lb. and describes ambergris

which once belonged to the Dutch East India Company[3]. Even here van Beneden and Gervais (p. 304) thought they should record this gigantic mass cautiously and therefore suggested that it might be an agglomerate of several pieces stuck together while in some plastic state fresh from the sperm whales. But the present haul weighs only 56 lb. less, so it seems reasonable to admit this 982 lb. mass from the Dutch East India Company to be the largest known mass of ambergris, with the present haul of 926 lb. taking second place. A lump practically as large, weighing 924 lb. (420 kgm.), is recorded from a sperm whale taken on the Australian coast many years ago[4].

The present mass is 65 in. long and its greatest diameter measures 30 in. In the same factory ship, on November 21, 1947, and in 55° 59′ S., 03° 32′ E., I had the good fortune to find and examine a smaller, but still notable, boulder of ambergris which weighed 340 lb. and measured 26 in. across its greatest diameter[5]. Presumably because of their size, very large lumps of ambergris have been said to be invariably found in the stomach of the whale and not in the intestine[6]. But both masses from the *Southern Harvester* were found in the large intestine, which is the organ where I have in the Azores once or twice found small 'parcels' of ambergris, and where, indeed, have been made all those ambergris finds inside the whale for which reliable accounts exist. Now, without measurements to hand, I recollect the adult sperm whale's large intestine as measuring 6 or 7 in. in collapsed diameter. These ambergris weights and measurements, combined with a glance at Fig. 1, therefore show how astonishing it is that a sperm whale is able to carry, within an intestine which can distend fourfold without rupturing, such a vast weight in its body and can still maintain its digestive processes and not appear obviously sick. For both these whales had food in their stomachs and both were in good condition, although for nearly two centuries it has been customary to say that ambergris comes only from sick, lean whales.

The nature and origin of this intriguing substance are problems which deserve to be re-examined. Modern text-books either describe ambergris as a "biliary concretion" or as a substance arising from irritation of the intestine by the horny beaks of the squid which form the chief food of the sperm whale. Schwediawer[7], however, in 1783, wrote: "We may therefore define Ambergris to be the praeternaturally hardened dung or faeces of the Physeter Macrocephalus, mixed with some indigestible relics of its food". By the examination of these two great masses, and of smaller finds, and by descriptions in the literature, I am led to a similar conclusion. Local increase in water absorption by the large intestine, and the chemical transformations enacted by the resident intestinal bacteria, probably each play their part in the formation of ambergris from fæces impacted around some matrix of indigestible material.

It may be possible to produce ambergris in the laboratory by incubating sperm whale fæces in suitable conditions. The matter is of some commercial importance because ambergris is still a valuable commodity without equal as a fixative in perfumes.

An account of ambergris is projected which, besides describing its history and mythology, its composition, properties and uses, will attempt to explain its origin in the whale in the way briefly indicated here.

I would like to thank Messrs. Chr. Salvesen and Co., owners of the *Southern Harvester*, for their facilities in 1947–48 and in May of this year when I examined the new find; I am grateful to Mr. Desmond King and to Commander Percy Ashe, R.N., respectively chief chemist and whaling inspector of the vessel, for their kind assistance.

[1] Verrill, A. H., "The Real Story of the Whaler" (New York and London, 1916).
[2] Clarke, R., "Discovery" Rep. **26**, 281 (1954).
[3] Beneden, van, and Gervais, P., "Osteographie des Cetacés vivantes et fossiles" (Paris, 1880).
[4] Murdoch, W. G. B., "Modern Whaling and Bear Hunting" (London, 1917).
[5] Clarke, R., *Soap Perfum. Cosm. Tr. Rev.*, **22**, 147 (1949).
[6] Stirling, A. C., *Chem. and Drugg.*, **120**, 294 (1934).
[7] Schwediawer, *Phil. Trans.*, **73**, 226 (1783).

SOME CHEMICAL ASPECTS OF ABNORMAL GROWTH*

By Prof. F. BERGEL
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SOME chemical aspects of normal growth and development were considered by me last year[1]; very little has since been published to add to our limited knowledge in these fields. This is particularly so with respect to the fundamental problem of reduplication of specific functional and structural macromolecules in the cell[2–5]. In this article I shall deal with chemical-biological problems connected with abnormalities of growth and development of a non-malignant character. One has to assume that during the normal processes a most admirable harmony prevails between the stimuli and inhibitors which act at the right moment on the correct cell or tissue receptors. When this harmony is upset, disorders of growth, or during embryonic stages, disturbances of differentiation and morphogenesis, or both, are produced. The expert can recognize them on a cellular, tissue, organ or whole-body level[6–8].

Disorders of Growth

One distinguishes between hypertrophic and hyperplastic states, on one side, and atrophic and hypoplastic on the other. The latter, which amount to diminution in size of an organ or muscle, are due to shrinkage of tissue or reduction in the number of cells respectively and are usually connected with lowered metabolism. Whether this is caused by old age, malnutrition, starvation, disuse or traumatic damage, the normal turnover of metabolites, that is, the synthetic and catabolic processes of the cells, has decreased. Often, vitamin deficiencies contribute to these reductions, resulting in irregularities of enzyme functions. In some cases they are the sole primary cause, as in the muscular dystrophy of rodents through vitamin E deficiency[9]. Hormonal deficiencies, apart from their overall effect, often produce glandular atrophies and hypoplasias: for example, pituitary dysfunction causes, under certain conditions, thyroid and adrenal hypoplasia[10]. Hypoplasia seems to be present also in the bone marrow of some anæmic patients; but pernicious anæmia and reticuloses often show the opposite, namely, hyperplasia.

This hyperplastic state, which is due to an increase in the number of cells above the normal, occurs

* Synopsis of two lectures given at the Pharmacology Department, University College, London, on February 4 and 9, 1954.

frequently together with hypertrophy, meaning an enlargement of cells, fibres and, with them, of tissues and organs. At other times, hypertrophy can be observed on its own, and might be of a physiological, adaptive or compensatory nature. While the pregnant uterus with its fibres enlarged ten times their length and four times their width represents a physiological case, the over-exercised motor muscle in the 'strong man' illustrates that of the adaptive mechanism. A typical example of the compensatory type can occur in double organs, such as the kidney, where, after removal or atrophy of one half, the remaining half is enlarged. This hypertrophic reaction can surprisingly be enhanced in rats, according to Gross and Meier[11], by dosing them with cortisone, which usually suppresses protein synthesis. Thus the biochemistry of hypertrophy and also of hyperplasia deserves further attention, particularly as the results may throw some light on that of malignancy.

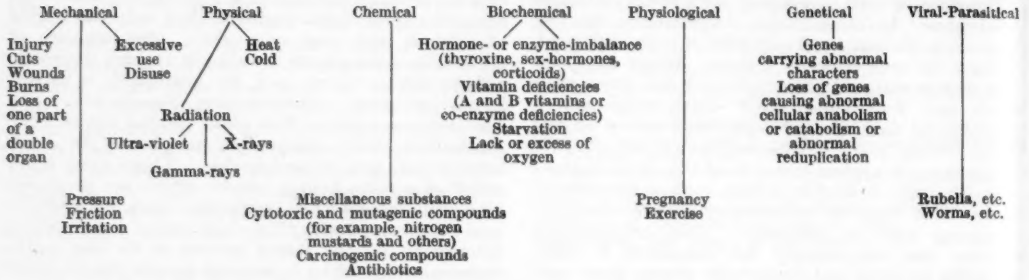
Before giving more details of abnormal growth, it may be useful to mention differences between the two forms of excessive growth which include benign tumours and neoplasia of a malignant character. Although the dividing line between benign abnormality and cancer is not always well defined, it can be said that the main differences are these: truly neoplastic tissue is capable of invading normal tissue, it can cause secondary tumours or metastases, is, under experimental conditions, transplantable within the same species, and shows histological and cytological irregularities. While it has been found that cessation of action of a stimulus or an appropriate inhibitor which may be one of the primary causative agents in the formation of hyperplastic and neoplastic tissue will lead to regression or even arrest of the former, malignant neoplasia shows irreversibility or autonomy. At present the most favoured hypothesis as to the cause of neoplasia on a cellular level is that the cell has undergone a change in its somatic-genetical characters and is gradually losing some of its differentiation characteristics. It has acquired, instead, the growth potency of immature embryonic cells without obeying, as they do, the controlling influence of the tissue to which they belong or the organism as a whole. However, biological and, particularly, chemical differences between cancer cells, abnormal and normal cells are more of a quantitative than a qualitative nature.

Numerous examples of such quantitative differences in biochemical behaviour have been quoted in the literature[12]. On the whole, benign hypertrophic and hyperplastic abnormalities yield, in several respects, results occupying a medium position between those obtained with normal and malignant material. This is the case[13], for example, with respect to the oxygen consumption in the absence and presence of succinic acid in conformity with Warburg's original observation of the preponderance of aerobic glycolysis in tumours. It also becomes manifest when comparing the amounts of trace elements present in normal, hyperplastic and neoplastic tissue[14,15]. As this problem of trace metals in tissues, particularly in view of the part played by some of them as enzyme activators, deserves further investigations with improved analytical methods, a start has been made by workers at the Chester Beatty Research Institute and the Royal School of Mines, London[16], to assay a great number of normal and abnormal tissues, including malignant tumours, as to their contents of major and minor metallic constituents.

In the following, a few examples of hypertrophic and hyperplastic conditions are given, together with relevant experimental findings. Not only the tissues of animals and man may show abnormalities of growth, but also plants are subject to such disorders, called 'galls'. Crown gall, for example[17], is caused by a microbe, *Agrobacterium tumefaciens*, and simultaneous injury. This plant tumour shows some similarities with mammalian neoplasms as it is autonomous and transplantable. There exist other galls[18] of a more benign nature which are produced by certain insects when laying their eggs, by insertion into the plant tissue. The character of these galls is determined by the insect species or by the active chemicals released by it, and not by the plant species. It would be very desirable if the substances causing these abnormalities could be isolated. This is the more important as growth regulators, such as indole acetic acid, when injected into plant tissue, can initiate the formation of galls having greater likeness to those produced by insects than to the malignant crown galls. But the situation is somewhat complicated by the fact that plant tissue, invaded by *Agrobacterium*, shows an increase in indole acetic acid content, and that early crown gall transfers[18] are suppressed by maleic hydrazide, a typical indole acetic acid antagonist. Although much can be learned from growth abnormalities in plants, their production by insects and relatively simple growth regulators should introduce an element of caution into comparing them directly with animal or human disorders. On the other hand, it has been established that the activity of protozoa, bacteria and viruses can lead to abnormalities in avian or mammalian tissues. This can be demonstrated in human skin[19] where, apart from verruca or warts, caused by mechanical trauma, possibly followed by an infection, a disease called molluscum contagiosum occurs. There the agent producing proliferation is a virus, while, in keratoderma blenorrhagica, cocci are responsible for the histological changes. We are only slowly learning what these changes mean in chemical terms, with regard to enzymes, proteins, nucleic acids and other cellular constituents.

It is not unlikely that continued investigations will reveal that other agents, whether physical or chemical, causing disturbances of growth, produce similar metabolic irregularities in the end. In the case of injury, taking again the skin as an example, where a most admirably ordered process of regeneration takes place normally, the repairing tendency, particularly of the connective tissue, may become exaggerated and collagen synthesis too abundant. The consequence is cheloid formation or scarring. Looking at other parts of the body, such as glands and organs, one finds that hypertrophic or hyperplastic changes can develop due to a number of different factors. In those parts of the body which are under the control of hormones, often an imbalance of hormonal production is at the back of pathological changes. One gland studied in great detail is the thyroid[10], where hyper- or hypo-activity of the iodo-thyronines may lead to various forms of goitre accompanied by other symptoms of ill-health. The sex organs are particularly sensitive to changes in the quantities of steroid derivatives such as œstrogens, androgens and progesterone, either as growth stimulants or inhibitors, and in this connexion it is interesting to note that Boyland *et al.*[20] have succeeded in producing hyperplasia in testes of young cockerels by application of certain sulpha drugs, such as sulpha mezathine.

Fig. 1. Possible Primary Causative Agents and Factors of Abnormal Growth and Development



The effect observed is independent of the bacteriostatic action of the drugs and is not neutralized by the administration of *p*-aminobenzoic acid or folic acid. Green[21], when injecting an androgen into goldfish, has succeeded in producing epithelial hypertrophies, which the males develop normally during the breeding season on gill plates and pectoral fins. With regard to œstrogens, numerous results have been reported on their growth-stimulating effects[22]. While the original observation of hyperplasia of the whole uterus in rodents following prolonged application of such œstrogens was extended by Horning[22] in the rabbit to the formation of discrete tumours, so-called fibromyomata or fibroids, others, and particularly Lipschütz[23], found that under certain conditions female guinea pigs developed such fibroids, not only of the uterus but also of other organs in the abdominal cavity. Such proliferations, however, were reversible and regressed when the application of the œstrogenic substance was stopped; only in exceptional cases did they show irreversible and, thus, malignant properties. Lipschütz, who established that fibromatogenic activity went parallel with the œstrogenic activity of the drugs used, discovered that other steroids, among them progesterone, androgens and deoxycorticosterone, showed fibroid-preventing effects. Strangely enough, cortisone and related compounds turned out to be inactive. All these experimental results are, of course, of great value in human medicine, which has known the spontaneous formation of fibroids and non-malignant tumours for a long time. It seems that, in woman, sex hormone imbalance is also one of the causative factors.

There are in man a number of other organs which are prone to benign proliferative abnormalities, such as the intestines, the kidneys, the reticulo-endothelial system and others. Interesting results have been obtained by Haddow[24] when injecting rodents with certain analogues belonging to the group of pteridines and purines. Among others, the naturally occurring xanthopterin produced hypertrophy of the kidneys in experimental animals by stimulation of cell division in the epithelium of the tubules. These effects are reversible and may be due to interference with activity of enzymes. A number of substances synthesized by Timmis, Ross *et al.*[25] were therefore tested as to their inhibition on one of the enzymes of nucleic acid catabolism—namely, xanthine oxidase—and for their kidney effects. Although in some cases the *in vivo* and *in vitro* activities, or their absence in these two effects, showed good correlation, in others no such parallelism could be noted[25]. It is therefore unlikely that the hypertrophy is solely due to the inhibition of xanthine oxidase, and work is continuing on other enzymes and metabolic events.

Disorders of Development and Morphogenesis

Just as disorders of growth are the consequence of irregularities of cellular and tissue metabolism, so disturbances during the embryonic period and thereafter are followed by disorders of development and morphogenesis and result in malformation.

Last year[1] an attempt was made to summarize the state of the biochemistry of morphogenesis as reviewed by Needham[26], Brachet[27] and others. Space does not permit me to go into details as given during my recent lectures[28], and it must suffice to mention recent findings by Toivonen[29] which seem to confirm the existence of specific evocators, released by organizer regions and inducing in competent areas of the ovum the development of neural and mesodermal tissues. Brachet[30] has emphasized the close link between morphogenesis and the gradients of ribonucleic acid in the fertilized egg. He has also mentioned the disturbing effects of chemicals or oxygen deficiency, leading in extreme cases to the arrest of development. It becomes more and more apparent that any disturbance of the interplay between organizers and the growth process of the embryo will produce developmental disasters. Such disasters can be, of course, genetically conditioned in that the sperm or the egg have carried abnormal genes. As genes are known to control enzyme synthesis and the vital reduplication of other cellular constituents, it is obvious that abnormal ones will bring about abnormalities in the embryo. On the other hand, outside factors, whether they are of physico-chemical or parasitical nature, can cause maldevelopment and malformations. Thus, temperature, radiation, toxic concentration of ions or drugs do more harm during this sensitive period than at any other time. Giroud and collaborators[31] have demonstrated that slight vitamin deficiencies in the rat, which do not touch the mother animal, will produce most serious malformations in the embryo. While he has studied mainly the effects of shortcomings in the B group of vitamins, other vitamin deficiencies, such as A, etc., have been shown to cause maldevelopment even in the pig. A temporary lack of oxygen during incubation of chick eggs, as demonstrated by Büchner *et al.*[32], will lead to malformations of the heart and the major blood vessels, and cortisone, again in the same animal, according to Chester Stock *et al.*[33], suppresses overall growth. Forbus[9] describes, with regard to human pathology, a great number of abnormalities in whole organs and limbs, which are reminiscent of those produced experimentally as already mentioned. Apart from a complete breakdown of development which leads to production of amorphous embryonic masses, abnormal twinning may give rise

to the formation of monsters and teratomas which in the old days have often formed the subject of fairy tales and sagas. Giants and dwarfs are also described, or men with supernumerary or missing limbs, eyes and features. Each of these abnormalities is known to modern embryologists or pathologists as hyper- and hypo-genesis, including those malformations which, due to endocrine deficiencies, may turn up as late as in childhood or even later still.

All these disturbances of development have many features in common, in some yet incompletely recognized way, with disorders of cellular and tissue growth. Summarizing, it is permissible to speculate that they all derive basically from irregularities of cellular constitution or metabolism in the form of failures of normal protein or nucleic acid synthesis and thus enzyme or hormonal imbalance. Considering the possible primary causative agents and factors of abnormal growth and development, one can arrive tentatively at a diagram as shown in Fig. 1. In conclusion, one may state with Ingersoll: "In nature there are neither rewards nor punishment, only consequences".

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[4] cf. Fox, A. S., *Nature*, **173**, 350 (1954).
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[26] cf. Needham, J., "Biochem. and Morphogen." (Camb. Univ. Press, 1950).
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OBITUARY

Prof. T. G. Hill

THOMAS GEORGE HILL, emeritus professor of plant physiology in the University of London, died on June 25 at his home at Hambledon near Godalming in his seventy-ninth year.

Born in London in 1876 he was educated at St. Olave's Grammar School and the Royal College of Science. He was for a time demonstrator in biology at St. Thomas's Hospital and in later years seemed very proud of his early connexion with this Hospital. After holding various lectureships in the University of London he became, in 1912, reader in vegetable physiology at University College, London, and following F. W. Oliver's retirement in 1929, professor of plant physiology and head of the Department of Botany.

His Department was a very happy one; all students who entered it, and not only those reading special botany, were made to feel they were members of the Department. To undergraduates entering his Department for the first time 'T.G.' gave the appearance of being fierce and rather awe-inspiring. But as one got to know him better one realized that beneath the gruffness of manner he was a kindly gentleman—more than a little sentimental and not without his prejudices.

It is perhaps worth recording the advice 'T.G.' gave to one assistant lecturer he had appointed. "Prepare all your lectures carefully and thoroughly and always tear up your notes after you have given your lecture." His own lectures were models for any beginner to follow. He used few notes and spoke lucidly and fluently. It was a delight to listen to him build up an argument in a way that made the topic seem both logical and easy. The important points would be brought out by some telling phrase or striking analogy (generally far removed from botany). The result was a course of lectures which fifteen years later still remain vividly in the mind.

T. G. Hill's botanical researches fall into two parts. The first part of his researches was devoted to plant anatomy, and he never lost his interest in this field. His most important anatomical work was perhaps the series of papers published with Ethel de Fraine on seedling structure. The work was at first based on a phylogenetic point of view; but the final paper in the series (still worth reading) in the *Annals of Botany*, 1913, marked the end of an era. The point of view had changed; the varying structure of seedlings was not to be interpreted phylogenetically but physiologically; the investigation had become a study in causal anatomy.

The second part of Hill's researches concerned plant chemistry and metabolism and was carried out largely in collaboration with Dr. Paul Haas (then reader in plant chemistry). They were the first botanists in Great Britain to study an oxidation-reduction system, hermidin, from *Mercurialis perennis*. Later appeared a long series of biochemical papers on the metabolism of marine algae. This was pioneer work in a field the importance of which is only now being generally realized.

In 1913, with Dr. Haas, he wrote "The Chemistry of Plant Products", which became a standard work. It is now, of course, somewhat out of date, but Vol. 2 on "Metabolic Processes" can still be read by students with profit, for its dynamic method of approach and presentation. It must remain a matter of regret that the authors did not see fit to revise this work.

As a member of F. W. Oliver's Department, Hill paid many visits to Blakeney Point, Norfolk. One result of this was his paper (with J. H. Hanley) on "The Structure and Water Content of Shingle Beaches", as well as studies on the osmotic pressures of salt-marsh plants.

In 1915 he published "The Essentials of Illustration". This book was not without its effect upon the standard of illustrations in biological journals; but it never became well known and indeed was not noticed in any botanical journal. In later years 'T.G.' suggested that this might have been because some of the material he used for his illustrations was rather frivolous.

From 1911 T. G. Hill served in the University of London Officers' Training Corps. He was adjutant during the First World War, became major in 1917 and resigned his commission in 1919. During the Second World War he took his department to Bangor, where he entered into the teaching and demonstrating with a zest which must at times have been a trial to his hosts. He was nearly seventy when he retired.

'T.G.'s retirement was spent at his home in Hambledon. He was well known and liked in the village and will be remembered for his kindness, especially to the children. He was a keen supporter (and critic) of the Hambledon Cricket Club and served as president. He was also at one time president of the now defunct Hambledon Garden Club.

During the post-war years he became a governor of Guildford Technical College, in which he took a great interest. Characteristically, he resigned a few months ago, when he was no longer able to get to the governors' meetings.

At University College 'T.G.' was well known and well liked in the smoking room. He will be remembered with respect and affection by many students and colleagues.

D. J. B. White

NEWS and VIEWS

Biochemistry at Oxford : Sir Rudolph Peters, F.R.S.

Sir Rudolph Peters retires at the end of the present academic year from the Whitley professorship of biochemistry in the University of Oxford, a post he has held since 1923. Peters studied as an undergraduate at Caius College, Cambridge, of which he became Drosier Fellow and Tutor. He took his B.A. in 1911 and graduated M.B., B.Chir. in 1915. After research and lecturing in biochemistry at Cambridge he joined the R.A.M.C., being awarded the M.C. with bar during the First World War. In 1919 he gained the M.D. degree of Cambridge. At Oxford, from 1923 onwards, he built up a flourishing school of dynamic biochemistry and found the first clue to the mode of action of thiamine from a study of its *in vitro* effects on metabolic processes. In the Second World War the development of British Anti-Lewisite, a substance of usefulness in a wide range of metallic poisonings, was a delightful example of the practical outcome of theoretical considerations. More recently, Peters has investigated the toxic action of fluoroacetic acid and has elegantly demonstrated how the incorporation of this substance into constituents of the tricarboxylic acid cycle leads to toxic action.

Peters has earned many distinctions. He was elected a Fellow of the Royal Society in 1935, receiving a Royal Medal in 1949 and delivering the Croonian Lecture in 1951. Many honorary degrees and many distinguished lectureships have been held by him, including the Dunham Lectureship at Harvard University. During 1946–50 he was a member of the Medical Research Council. Caius College elected him an Honorary Fellow in 1951. Fortunately, he will not be lost to the world of science on his retirement from Oxford, since he takes up a post with the Agricultural Research Council at the Institute of Animal Physiology, Babraham.

Prof. H. A. Krebs, F.R.S.

Prof. H. A. Krebs has been appointed to succeed Sir Rudolph Peters as Whitley professor of biochemistry at Oxford. He has been professor of biochemistry in the University of Sheffield since 1945, and the award to him, jointly with Dr. F. Lipmann, of the Nobel Prize for Medicine for 1953, was noted in these columns last year (*Nature*, **172**, 837; 1953). Prof. Krebs was educated at the Universities of Göttingen, Freiburg i. B., Munich and Berlin, being assistant in the Department of Prof. Otto Warburg at Berlin-Dahlem during 1926–30. He went to Cambridge as a Rockefeller Research Student in 1933 and was appointed demonstrator in biochemistry in that University in the following year. In 1935 he was appointed lecturer in pharmacology in the University of Sheffield, a post which was afterwards converted to that of lecturer in biochemistry and then to professor. Since 1945 he has also been director of the Medical Research Council Unit for Research in Cell Metabolism at Sheffield.

Prof. Krebs's work has largely been concerned with the study of metabolic processes *in vitro*. In 1932, in collaboration with Henseleit, he proposed a mechanism for the formation of urea in the liver with the participation therein of ornithine, citrulline and arginine by means of a cyclical process, a theory that was afterwards the centre of controversy, although it is now widely accepted. In 1937 he put forward his now classical citric acid cycle as a pathway of oxidation of carbohydrate, and it has since become clear that this cycle is concerned not only with oxidation of carbohydrate but also with that of fat and of protein. Indeed, as the years have passed, the importance of the citric acid cycle has grown rapidly, and Krebs's original idea has been amplified rather than modified. More recently, Krebs and his colleagues have been especially interested in the movement of substances across membranes, and the significance of such movements in metabolic processes in general. His Medical Research Council Unit will accompany him to Oxford, and it is to be hoped that there will be no more than a slight interruption of research as the result of this move.

Evidence for the Antiproton

It is firmly believed by most theoretical physicists that the antiparticle to a proton can exist. Indeed, if the proton is to be described by a modification of the Dirac equation, the existence of negative energy states is required. This particle should bear the same relation to a proton as does the positron to an electron. Should it be possible to create such a particle

by a proton–nucleon collision, the incident proton will require a kinetic energy of at least $5{\cdot}6 \times 10^9$ electron volts. At present only one particle accelerator, the Berkeley 'Bevatron', exists which is designed to reach this energy. At this energy the production of antiprotons is not expected to be very copious, and their abundance relative to other particles formed will probably be far smaller than in many cosmic ray phenomena which have already been extensively investigated. The problem of the conclusive identification of the antiproton may be a difficult one for some time to come. A direct mass and sign measurement might be expected to identify it. However, this would require a high precision to distinguish it from known negative heavy mesons of mass greater than half the proton mass. Further, any such direct mass and sign determination could, in itself, always be attributed to a new type of negative heavy meson.

There is a characteristic feature of an antiproton that should render its identification more simple. On coming to rest in matter, an antiproton should be attracted into the nucleus of an atom and annihilate itself and one ordinary proton. This process, liberating as fast mesons (or less probably γ-rays) twice the rest energy of the incident particle, is by definition unique to an antiparticle, and should be readily observed. One cosmic ray event has been seen in a multiplate cloud chamber by DeStaebler, Bridge, Courant and Rossi (*Bull. Amer. Phys. Soc.*, **29**, No. 4, 74; 1954), which is consistent with this process, and hard to reconcile with an alternative explanation. Within the past year the use of large blocks of nuclear emulsions, and the combination of magnet and multiplate cloud chambers, have both greatly increased the amount of information that may be obtained from the observation of a single particle. It is quite possible that with the aid of these techniques conclusive evidence for the existence of the antiproton may be found in the near future. Moreover, it may become possible to identify the annihilation products of machine-produced antiprotons by a counter experiment, even if the particle is not detected.

Recollections of Lord Rutherford

At the request of a number of its Fellows, the Physical Society has reprinted the first five of its Rutherford Lectures in a booklet entitled "Rutherford by those who knew him" (pp. 69; from the Physical Society, 1 Lowther Gardens, London, S.W.7; 1954; 5*s*. to members or 8*s*. 6*d*. to non-members, with 6*d*. postage). All five Lectures are reminiscent in character and are obviously tributes by men who, like so many, if not all, of Rutherford's research workers, had fallen under the magic spell of their chief. There are a number of illustrations, some of which are rather charming in that they are snapshots, for the most part rather poor ones, taken from photographic albums and no doubt highly prized by their owners; unfortunately, the reproductions are very poor. The Lectures are by Prof. H. R. Robinson (Manchester period); Sir John Cockcroft (Cambridge period); Prof. M. L. Oliphant; Dr. E. Marsden; and Dr. A. S. Russell (Manchester period). Perhaps the Lectures by Prof. Robinson, Sir John Cockcroft and Dr. Russell are the more personal, or even anecdotal, of the five; Prof. Oliphant's Lecture is an attempt, in all too short a space, to appraise the impact of Rutherford and his work upon the science and life of the present time, and Dr. Marsden, as befits the only New Zealander, for the most part emphasizes the importance of Rutherford's early New Zealand background in the development of his character. The Lectures make fascinating reading, because their subject was a fascinating personality. Perhaps none has summed up Rutherford better than the late Sir James Jeans in a tribute shortly after Rutherford's death: ". . . In his flair for the right line of approach to a problem, as well as in the simple directness of his methods of attack, he often reminds us of Faraday, but he had two great advantages which Faraday did not possess—first, exuberant bodily health and energy, and second, the opportunity and capacity to direct a band of enthusiastic co-workers. Great though Faraday's output of work was, it seems to me that to match Rutherford's work in quantity, as well as in quality, we must go back to Newton. Rutherford was ever the happy warrior—happy in his work, happy in its outcome, and happy in its human contact".

Nuclear Reactor in Stockholm

On July 13 a nuclear reactor moderated with heavy water and using natural uranium was started in Sweden. The reactor, which is of the *CP* 3 type, has been built by the Atomic Energy Co. in Stockholm, a company jointly owned by the Government and private industry. The reactor is located in an underground room in the neighbourhood of the Royal Institute for Technology. Construction was started in the middle of 1951. The designed power is 300 kW. and the heat is dissipated by circulating the moderator through a heat exchanger, where it is cooled by air.

Work of the British Council

The tribute to the value of the work of the British Council which was paid six years ago by the Select Committee on Estimates was fully endorsed on both sides of the House of Commons in the debate on Overseas Information Services on July 6. That debate arose essentially out of the failure of the Government to reach any decision on the recommendations for the re-organization of these services in the report presented a year ago by Lord Drogheda's Committee. The second annex to that report, of which a summary was published in April last (Overseas Information Services. Miscellaneous No. 12 (1954): Summary of the Report of the Independent Committee of Enquiry into the Overseas Information Services. (Cmd. 9138.) Pp. 56. (London: H.M.S.O., 1954.) 1*s*. 9*d*. net), reviews the work and requirements of the British Council and, while making proposals for curtailment and rearrangement of the Council's work in Europe, stresses the value of the work being done elsewhere. The Drogheda Committee was well impressed with the standard of the staff in those British Council centres it visited, and directs attention in this report to the importance of establishing a long-term programme for British Council work overseas and sticking to it if staff of high quality are to be attracted and freed from the atmosphere of frustration and uncertainty in which the Council works to-day. The recommendations of the Drogheda Committee, including provisions for pensions, staff allowances, etc., would increase the total annual grants to the British Council by about £630,000, thus restoring the position to about what it was during 1948–49. What it believes the British Council needs more than anything else is a five-year programme of development with some guarantee that the necessary funds will be provided for its execution.

This principle of the quinquennial grant found general support in the debate on July 6, and the need for continuity was admitted even by the Government spokesman, Mr. Anthony Nutting, though he declined to commit the Government to any specific action on the report; by implication, he rejected the essential recommendation of the Committee, namely, that information work, whether conducted by the British Broadcasting Corporation, the British Council, the Central Office of Information or individual Government Departments, should be viewed as a whole with its strategy planned and its finances guaranteed over a period of years. While it would thus appear that the Government is unwilling to accept the Drogheda Committee's suggestion of a permanent Advisory Committee, Mr. Nutting joined with other speakers in repudiating emphatically the attacks made on the British Council and its work, particularly those being made in the Beaverbrook press. The British Council Staff Association has recently replied to these attacks by publishing at its own expense a pamphlet entitled "The Beaverbrook Press and the British Council" (pp. 12; 6*d*.), and this pamphlet was commended by the Minister. It is just such occurrences which the Press Council was formed to investigate, and it is to be hoped that the Council will in due course take up the matter.

Ciba Foundation: Support for Gerontological Studies

The Ciba Foundation has decided to support experimental work and basic investigations into the problems of ageing as an additional item in its general programme for the promotion of international co-operation in medical and chemical research. An extra sum of money has consequently been set aside for gerontological studies over the next five years, and these studies will take the form of regular colloquia, informal discussion meetings, lectures, special awards and travelling fellowships. The recent colloquium on "Aspects of Ageing", held by the Foundation during July 14–16, was the first of a series in this field, and the proceedings of this colloquium will be published as a series of volumes on lines similar to the Foundation's well-known "Colloquia on Endocrinology". When the opportunity occurs, guests staying in the Foundation with special knowledge in gerontology will be invited to open informal discussion meetings. The annual Ciba Foundation Lectureship will be open to distinguished workers in the field. For the Foundation's awards for original researches, candidates are invited to submit unpublished work (though it may be under consideration for publication), and prize-winning entries may be printed in English and bound periodically to form a separate series of volumes representing international progress in the field. It is proposed to make five such awards in the first year, of an average value of £300 each, but the size and number of the awards may be varied according to circumstances. The Foundation will also from time to time make grants for travelling fellowships, especially where it is considered that candidates would benefit from a visit or visits to laboratories in another country.

Cairngorms Nature Reserve

The declaration by the Nature Conservancy in Edinburgh on July 9 of the Cairngorms Nature Reserve brought into existence much the largest nature reserve in Great Britain and one of the largest in Europe. The 62 square miles, or 39,689 acres, now declared omits Cairngorm but includes the three highest summits and is slightly larger than the 38,000-acre area originally recommended by the Scottish Wild Life Conservation Committee. Only about one-eighth of the area, covering the higher lands of Invereshie, has been bought by the Conservancy. The remainder is brought in under a series of nature reserve agreements which are the first under Section 16 of the National Parks and Access to the Countryside Act, 1949, to be completed between the Nature Conservancy and private landowners. It is also planned later to enlarge the Reserve, which is intended to preserve as nearly as possible unchanged this grand stretch of country and its highly interesting wild life and vegetation for the enjoyment of the present and future generations and for scientific study. There will be no charge as regards access, but formalities will be required for those wishing to undertake research, to take specimens of animals or plants (which will be prohibited except for scientific purposes) or to obtain permits for camping. Applications for collecting or other scientific purposes should be addressed to the Nature Conservancy at 12 Hope Terrace, Edinburgh 2. Two Conservancy wardens are already in residence and will be glad to inform and assist visitors. Deer-stalking, grouse-shooting and the destruction of a few undesirable pests will continue, but special protection zones have been arranged for ptarmigan, and no birds of prey except sparrowhawks will be killed.

A strong Cairngorms Consultative Panel has been established to advise the Conservancy on all matters affecting public rights and interests, including mountain rescue arrangements, and the Conservancy hopes to assist in the provision of footbridges and the care of mountain shelters. The programme of scientific investigations will probably include the natural regeneration of native Scots pine in the remnants of the Caledonian Forest, the ecology of mountain birds, plants and insects, and high-altitude meteorology. The primary object of the Reserve, however, is to safeguard its characteristic Highland wild-life, including the golden eagle, ptarmigan, dotterel, snowbunting, blackcock, greenshank, crested tit and Scottish crossbill, as well as red deer and roedeer, wild cat and other mammals, and more than two hundred species of flowering plants and hundreds of species of non-flowering plants and invertebrates, many of which are of considerable rarity and interest.

Society for the Promotion of Nature Reserves

The 1953 handbook of the Society for the Promotion of Nature Reserves gives an account of the eight reserves administered by the Society: Woodwalton Fen (Huntingdonshire), Dancer's End (Buckinghamshire), Meathop Moss (Westmorland), Badgeworth Marsh (Gloucestershire), the Coward Memorial Reserves (Cheshire), Mickfield Meadow (Suffolk), Sharpham Moor (Somerset) and Bellairs Great Wood (Essex). All these reserves were established in order to preserve certain rare plants, insects or birds, and each year their value becomes greater with increasing housing development and the consequent destruction of areas of interest to the naturalist. Among the species protected in the reserves are *Fritillaria meleagris*, *Ranunculus ophioglossifolius*, *Carex evoluta* and *Salvia pratensis*. The international aspect of Nature protection is described in the report of the meeting at Salzburg of the International Union for the Protection of Nature,

which was attended by more than a hundred people of thirteen different nationalities who met to discuss the effect of tourism on Nature protection and protection of fauna and flora in high altitudes. The handbook, price 5*s*., can be obtained from the Honorary Secretary, Society for the Promotion of Nature Reserves, British Museum (Natural History), Cromwell Road, London, S.W.7.

The Marsupial 'Tiger Cat'

EXCEPT for their uniquely spotted coats, in outward appearance and their flesh-eating habits the pouched dasyures or native 'cats' of Australia most nearly resemble foreign carnivores of the weasel family. Excellent photographs have been taken of a male and female of the much larger and generally fiercer 'tiger cat' which had been caught in the act of raiding poultry yards in Sydney; these are described by Ellis Troughton in a recent issue of the *Australian Museum Magazine* (**11**, No. 5; March 1954). Their captor, Mr. H. Grant, a retired sergeant of police, not only tamed these habitual raiders of the bush but also reduced them to a remarkable state of docile affection. After their capture about six months ago, five young were discovered attached to teats within the shallow-edged pouch of the mother. Their lusty growth gave opportunity for most interesting observations in captivity. The yellowish-brown tiger cat, which is the largest of the native cat group, attaining a length of 4 ft. from nose to tail-tip, is distinguished by having the creamy white spots extending down the tail, instead of being restricted to the body as in all the smaller native cats. Despite size, the tiger cat is an expert climber with a well-developed great-toe which is lacking in the more terrestrial native cats. It has been seen to leap from topmost branches of trees to catch roosting fowls by the neck, killing them in the act of falling with the body to the ground. The tiger cat is plentiful in Tasmania, which has become the last refuge of the largest known marsupial carnivore, the pouched 'wolf' or 'tiger'. It inhabits eastern Australia from the southern border of South Australia to the Cairns region of Queensland, where a smaller geographical race (*gracilis*) is known to occur.

Diseases and Pests on Horticultural Planting Materials

THE Ministry of Agriculture and Fisheries has prepared a special guide, by Mr. P. Aitkenhead and Dr. J. A. Tomlinson, entitled "Diseases and Pests on Horticultural Planting Material: a Guide to their Recognition" (pp. 38. London: H.M.S.O., 1953; 6*s*. net), designed primarily for the information of the Ministry's inspectors in their new duties under the Plant Protection Convention, 1951, of the Food and Agriculture Organization, which requires, among other things, inspection of consignments of plants moving in international traffic. A large number of insect pests and fungus diseases is described in the guide. The style is almost terse, but quite adequate for the purposes of a field-book setting forth to give a specific *ad hoc* determination against a general background of phytopathological knowledge. Host plants are, most conveniently, listed alphabetically, and the guide deals with the semi-dormant planting forms of ornamental and useful plants. Perhaps the most useful feature, however, will be the eighty-three excellent half-tone illustrations; these are from many sources, and certainly enhance the booklet.

Bell Solar Battery

THE June number of the *Bell Laboratories Record*, the semi-popular journal published by the Bell Telephone Laboratories, Inc., of New York, is of unusual topical interest by reason of some articles on transistors, and especially of an account of a new silicon device termed the Bell solar battery. The recent use of silicon in semi-conducting devices is the culmination of more than twenty years of work at the Bell Laboratories, and the solar battery is the result of the development by G. L. Pearson, C. S. Fuller and D. M. Chapin—physicist, chemist and electrical engineer, respectively—of a successful device for converting the sun's energy into electricity. In its present experimental form, the battery has an efficiency of 6 per cent and is expected to reach 10 per cent, in contrast with other photo-electric devices which have never achieved more than 1 per cent. The battery is constructed of wafer-thin silicon strips about the size of razor blades; these are linked together electrically to deliver power from the sun at the rate of 50 W. per square yard of surface. Illustrations accompanying the article refer to possible applications to the driving of a small electric motor and to the operation of a mobile radio transmitter.

International Scientific Radio Union

THE eleventh General Assembly of the International Scientific Radio Union (U.R.S.I.) will be held in The Hague during August 23–September 2. A report on the previous meeting, which was held in Sydney, was published in *Nature* (**171**, 628; 1953), and this included a full list of the officers of the Union elected for the forthcoming assembly. The Union is composed of national committees which contribute by subscription to its income, and, as a result, are entitled to official representation and participation in the scientific work before and during each General Assembly. The British National Committee for Scientific Radio is organized under the auspices of the Royal Society with Sir Edward Appleton as chairman. This committee has nominated a British delegation comprising a number of scientists directly interested in various aspects of measurements and standardization, radio-wave propagation, atmospherics, radio astronomy and the scientific problems of electronics, waves and circuits. Some of these delegates will be responsible for submitting, on behalf of the British National Committee, reports to the General Assembly reviewing the advances made in the United Kingdom in each of the fields of research indicated by the seven commissions of the Union. These reports and the corresponding ones submitted by other national delegates will be supplemented by other original contributions describing recent research work of direct interest to the international aspects of scientific radio. The General Assembly will also be considering the proposals for enhanced radio observations during the International Geophysical Year, 1957–58, as already incorporated in the preliminary programme drawn up by the special committee composed of representatives of all the international scientific unions interested in this work.

Physical Society: Forthcoming Meetings

A CONFERENCE on "The Physics of the Ionosphere" has been arranged by the Physical Society and will take place at the Cavendish Laboratory, Cambridge, during September 6–9. The Conference,

which is being organized by Mr. J. A. Ratcliffe, will be devoted mainly to a discussion of the following topics: (*a*) the lowest ionosphere; (*b*) irregularities and movements in the ionosphere; (*c*) the ionospheric *F*2 layer; (*d*) the mathematics of wave propagation through the ionosphere. Accommodation can be provided at Cambridge; application forms, which are obtainable from the offices of the Physical Society, should be returned to the Cavendish Laboratory, Cambridge, before August 16.

The seventh Rutherford Lecture of the Physical Society will be delivered by Prof. P. M. S. Blackett on November 26 in the Lecture Theatre, Science Museum, Exhibition Road, London, S.W.7, at 5 p.m. His subject will be "The Organization of Scientific Discovery". At a Science Meeting of the Society to be held on November 5, at 5 p.m., in the Lecture Room, Royal Astronomical Society, Burlington House, London, W.1, the Duddell Lecture will be delivered by Prof. A. C. B. Lovell on "The Development and Use of Large Radio Telescopes", and the Charles Vernon Boys Lecture will be given by Dr. J. S. Courtney-Pratt on "Some New Methods of Fast Photography". These lectures are open to non-members of the Society.

United States Fellowships for British Scientists

Nine fellowships for research in American institutions have been awarded to British scientists under a technical assistance programme sponsored by the United States Foreign Operations Administration. This will bring to eleven the number of fellowships awarded to British scientists since the inception last year of this programme, which provides for about a hundred and fifty younger scientists from fourteen Western European countries to undertake advanced study at American universities and research institutions, about twenty-five of the total being from the United Kingdom. The latest British awards, which have been made by the National Academy of Sciences, Washington, D.C., on the nomination of the Royal Society of London, are to the following for study at the institutions indicated: Dr. D. R. Bowsher (assistant lecturer in anatomy, University of Liverpool), Harvard Medical School; L. Castillejo (lecturer in physics, University College, London), Cornell University; Dr. B. R. Coles (lecturer in metal physics, Imperial College of Science and Technology, London), Carnegie Institute of Technology; Dr. F. M. Dean (lecturer in organic chemistry, University of Liverpool), University of California; Dr. R. F. Evans (Chemical Research Laboratory, Teddington), Purdue University; Dr. V. A. Knivett (Chemical Research Laboratory, Teddington), University of Wisconsin; A. G. Milnes (Royal Aircraft Establishment, Farnborough), United States Naval Ordnance Laboratory, Silver Spring, Maryland; Dr. J. Owen (Magdalen College, Oxford), University of California; and Dr. E. M. Thain (Lister Institute of Preventive Medicine, London), University of California.

Heriot-Watt College, Edinburgh: Fellowships

Honorary fellowship of the Heriot-Watt College, Edinburgh, has been conferred on the following, all of whom are former students of the College: Mr. C. Batey, printer to the University of Oxford; Mr. R. C. M. Dickson, Scottish representative director of Boots Pure Drug Co., Ltd.; Mr. W. B. Laing, general manager of Bruce Peebles and Co., Ltd., Edinburgh; Sir William Paterson, chairman and managing director of the Paterson Engineering Co., Ltd., London; and Dr. Rameshawr P. Sinha, principal of Dhanbad School of Mines, India. Fellowships by thesis have been awarded to the following: Ralph A. Aitken (enzymolysis of cell-wall materials with special reference to the malting process), and Sailendra N. Ghosh (new network analyser).

Society for Applied Bacteriology: Officers

The following have been elected officers of the Society for Applied Bacteriology: *President*, Mr. S. B. Thomas; *Secretary*, Mr. G. Sykes (Boots Pure Drug Co., Ltd., Microbiology Division, Nottingham); *Treasurer*, Mr. C. S. Miles; *Editors*, Dr. S. E. Jacobs and Dr. L. F. L. Clegg; *Publications Manager*, Mr. E. A. Whitlock; *Advertising Manager*, Mr. E. J. Mann; *Ordinary Members of the Committee*, Dr. L. A. Allen, Mr. K. R. Butlin, Mr. J. W. Egdell, Dr. L. D. Galloway, Dr. A. Hirsch, Dr. M. Ingram, Mr. D. A. McKenzie, Mrs. A. C. Stirling and Dr. Helen R. B. White.

Announcements

The Scientific Instrument Manufacturers' Association has elected as its president for 1954–55 Mr. C. E. T. Cridland, chairman and managing director of a group of companies which includes Aldis Brothers, Ltd., of Birmingham. Mr. Cridland was trained as an electrical engineer, and has been connected with engineering industry all his life, particularly electrical and aeronautical engineering.

The Committee representing the Royal Society and the Armourers and Brasiers' Company has appointed Mr. K. E. Puttick to be Armourers and Brasiers' Company Research Fellow from October 1, 1954, to work at the H. H. Wills Physical Laboratory, University of Bristol, on the structure and deformation of pearlite.

The Council of the Royal Society has awarded Mr. and Mrs. John Jaffe Donation Studentships from October 1, 1954, to the following: Dr. Eileen N. Richardson, to work at the Physical Chemistry Laboratory, University of Oxford, on the kinetics of bromination of selected aromatic compounds; and Mr. A. Korner, to work at the Department of Biochemistry, University of Cambridge, on the influence of hormones on metabolism.

An award under the Royal Society and Nuffield Foundation Commonwealth Bursaries Scheme together with financial support from the Board of the Dairy Research Institute, Palmerston North, New Zealand, has been made to Dr. S. Y. Thompson, of the National Institute for Research in Dairying, Reading, to enable him to visit the former Institute in 1955 in order to study factors controlling the vitamin A potency of New Zealand butter.

The University of Padua is offering a Gabriella Zuccari scholarship of 300,000 lire for research of at least six months duration at the Zoological Station, Naples, during the academic year 1954–55. The scholarship is open to any person who wishes to undertake research in zoology, comparative anatomy, physiology or embryology. Application forms (to be returned by October 30) can be obtained from the Secretariat of the University of Padua.

Erratum. In the communication of May 15, p. 956, on the "Life-history of the Rat Lung-worm and its Migration through the Brain of its Host", by Dr. M. Josephine Mackerras and Miss Dorothea F. Sandars, the two illustrations should be interchanged.

UNIVERSITY AFFAIRS IN GREAT BRITAIN, 1952–53

THE "Returns from Universities and University Colleges in receipt of Treasury Grant for the Academic Year 1952–53"*, issued by the University Grants Committee, shows a further decline of 1,984 in the number of full-time students—to 81,474, compared with 83,458 in 1951–52 and 85,314 in 1950–51. In the English universities, full-time men students decreased by 1,231, but women students increased by 282; for Wales the corresponding figures were 259 and 17, while for Scotland there were 694 fewer men and 99 fewer women. Overseas students from within the British Commonwealth increased by 318 to 4,239 full-time and 1,842 part-time students, and students from foreign countries by 190 to 3,229 full-time and 1,302 part-time students. While there was no significant change in the percentage distribution of full-time students among the faculties, there was no evidence of any increase where it appears to be required in the national interest. Arts students decreased by 1,020 to 34,916, but those in pure science decreased by 52 to 17,001 and those in technology by 222 to 9,993. Students of medicine decreased by 399 to 13,511, of dentistry by 174 to 2,715, of agriculture by 139 to 2,279, and those of veterinary science increased by 22 to 1,059. Full-time advanced students of pure science, however, increased by 187 to 3,045, and those of technology by 52 to 1,157 and of agriculture by 7 to 281; students of medicine and dentistry decreased by 44 to 963, of veterinary science by 3 to 7, and of arts by 10 to 3,304, while those working for a teacher's diploma decreased by 76 to 2,900. Of the full-time students, 64,753 were reading for a first degree, 5,064 for a first diploma and 11,657 were engaged in research or other advanced work, the corresponding figures for 1951–52 being 66,409, 5,505 and 11,544, respectively.

The proportion of assisted students was slightly smaller (70·4 per cent compared with 72·4 per cent during 1951–52); for England as a whole, it decreased only from 73·8 to 72·9 per cent, but in Wales it decreased from 88·3 to 81·1 per cent, and in Scotland from 61·6 to 55·7 per cent. The dependence on Parliamentary grants, however, continued to increase and is now 69·6 per cent of recurrent income, only 12·7 per cent coming from fees, 4·4 per cent from endowments, 3·6 per cent from local-authority grants and 1·6 per cent from donations and subscriptions. Two years ago (1950–51) the corresponding figures were 16·6, 5·2, 4·1 and 1·9 per cent, respectively, with 64·9 per cent from Parliamentary grants. The ratio of staff to students continued to improve, the full-time teaching staff being now 9,098, compared with 8,952 during 1951–52 and 8,603 during 1950–51. The increase was chiefly in readers, assistant professors and independent lecturers (38), senior lecturers (71) and lecturers (364), with a further decrease of 255 in assistant lecturers and demonstrators to 1,282.

Of the full-time students, 62,635 were in England, 4,621 in Wales and 14,218 in Scotland. Of these, 14,717 were at Oxford and Cambridge, 18,199 at London and 29,719 at other English universities and university colleges. There were slight decreases at all universities and university colleges, except Bristol (+ 9), Reading (+ 60), Exeter (+ 35) and North Staffordshire University College (+ 117), but only at Cambridge (− 152), Oxford (− 119) and Liverpool (− 182) was the decrease more than one hundred. The proportion of full-time students residing in colleges and halls of residence increased to 27·3 per cent; of these 22,269 students, 7,977 were at Oxford and Cambridge, 11,367 at other English institutions and only 1,188 in Wales and 1,737 in Scotland. The proportion of men in residence was 22·9 per cent and of women 41·3 per cent, while 32,559 students (40 per cent) were in lodgings and 26,646 (32·7 per cent) at home, compared with 39·6 per cent and 34·5 per cent during the previous year. Of the 21,355 students admitted for the first time during 1952–53 (a decrease of 1,059 on 1951–52), 19,683 were reading for a first degree, and 1,672 for a first diploma; and of those reading for a first degree, 1,612 were under eighteen years of age, and 10,679 were nineteen or more. Of the full-time students, 35,057 out of 48,044 men and 10,607 out of 14,591 women in England were receiving assistance in the way of scholarships, exhibitions or other awards from public or private funds; for Wales the corresponding figures are 2,588 out of 3,287 men and 1,161 out of 1,334 women; and for Scotland 5,942 out of 10,455 men and 1,980 out of 3,763 women. Of 61,786 full-time men students, 36·3 per cent were in arts, 21·9 per cent in pure science, 17·2 per cent in medicine and 15·9 per cent in technology; for the 19,688 women students the corresponding figures are 63·4, 17·5, 14·7 and 0·9 per cent, respectively. Medicine and dentistry claimed 49·1 per cent of the part-time advanced students, arts 33·8, technology 9·0, and pure science 7·5 per cent, compared with 51·1, 33·0, 8·0 and 8·7 per cent, respectively, during 1951–52.

The recurrent income of the universities and university colleges of Great Britain increased by £3,950,084 to £29,698,083, of which £20,682,415 was from Parliamentary grants, £3,764,749 from fees, £1,311,884 from endowments, £1,065,913 from grants from local authorities and £483,416 from donations and subscriptions. Of the total income from public funds of £21,748,328, and £7,949,755 from other sources, the University of London received £6,660,992 from public and £2,330,982 from other sources; the University of Cambridge similarly received £1,358,177 and £1,278,658; for Oxford, the corresponding figures are £1,220,380 and £733,576; Manchester, £1,068,409 and £265,774; Leeds, £891,496 and £259,220; Durham, £961,460 and £342,640; Birmingham, £856,834 and £252,077; Liverpool, £866,006 and £236,745; Bristol, £777,240 and £316,801; Sheffield, £544,693 and £165,201; Reading, £513,506 and £61,316; and Nottingham, £478,565 and £106,604. No other English university or university college had an income exceeding half a million pounds; but for the four universities in Scotland the corresponding figures were: Aberdeen £494,000 and £136,754; Edinburgh, £1,039,430 and £346,812; Glasgow, £1,021,000 and £349,223; and St. Andrews, including Dundee University College, £529,000 and £109,658. The University of Wales,

* University Grants Committee. Returns from Universities and University Colleges in Receipt of Treasury Grant, Academic Year 1952-53. (Cmd. 9130.) Pp. 44. (London: H.M.S.O. 1954.) 2s. 6d.

including the Welsh National School of Medicine, received £1,096,545 from public funds and £309,189 from other sources.

Of the total expenditure of £28,700,434, an increase of £2,568,312 or 9·8 per cent on 1951–52, administration accounted for 7·7 per cent, departmental maintenance 68·9 per cent, maintenance of premises 12·5 per cent, and miscellaneous expenditure 9·7 per cent. Capital expenditure met from income amounted to £334,516, and allocations to reserve to £334,015; for 1951–52 these figures were £258,963 and £222,536, respectively. Departmental maintenance, which includes salaries of teaching staff, payments for superannuation, the running costs of laboratories, lecture rooms, libraries and museums, and the supply of materials, apparatus, books, specimens, etc., increased by £1,665,428 to £19,761,880, and expenditure on the maintenance of buildings increased by 26·4 per cent. Salaries and superannuation amounted to £13,169,879 compared with £12,542,994 during 1951–52, the increase being 5 per cent for the teaching staff and 18·5 per cent for technicians and laboratory assistants.

Library expenditure, excluding general maintenance of library buildings, etc., rates, heat, light, repairs, etc., amounted to £1,118,428, or 3·9 per cent of the total expenditure, compared with 3·8 per cent during 1951–52 and 3·7 per cent during 1950–51. Of this total, £557,656 was for salaries and wages, £135,907 on periodicals and £90,072 on bindings. Of the £276,852 expended on books, £174,548 was in the schools and colleges of the University of London, including £9,800 at the Central Library, £7,222 at University College, £6,883 at the London School of Economics and £5,846 at the School of Oriental and African Studies. The University of Oxford spent £39,404 on books, Cambridge £16,014, Manchester £12,955, Liverpool £10,016, and Durham £10,265. The University of Bristol spent £9,739 on books, and the University of Southampton's expenditure of £9,152 is noteworthy in view of its smaller number of students; but although expenditure on books and periodicals continued to increase slightly, the upward trend was scarcely in proportion to the mounting costs of both books and periodicals. Only the Universities of London (£38,582), Cambridge (£10,247) and Oxford (£11,417) spent more than £10,000 on periodicals, and only Birmingham (£5,770), Leeds (£5,055) and Manchester (£5,460) more than £5,000. The University of Wales spent £11,869 on books and £7,987 on periodicals; in Scotland, Edinburgh spent £13,625 on books and £6,071 on periodicals; Glasgow, £13,421 and £7,711; Aberdeen, £6,619 and £3,733; and St. Andrews, £8,113 and £4,350.

SCIENCE IN THE EXTRA-MURAL WORK OF UNIVERSITIES

A SURVEY of some aspect of adult education from the pen of the *doyen* of heads of university extra-mural departments* is bound to attract attention and interest, and it is to be hoped that this essay will be carefully studied in responsible quarters. It will repay careful study, for there is much wisdom and good sense in its pages; but at the same time there is little to inspire, and the tone is cautious, almost apologetic. Thus, on p. 9 are set out the figures for courses in the sciences in relation to the total number of courses arranged by the universities and the Workers' Educational Association during the session 1952–53. Science provides 10 per cent of the total, and, while acknowledging that this represents "a considerable advance" on the 4 per cent of an earlier survey in 1925–26, Prof. Peers describes it as "remarkably low". In fact, however, an examination of the figures for all subjects scarcely confirms this judgment. In a total number of courses of 3,755 the physical and biological sciences, with 378, are exceeded by language and literature (623), the arts (599), history (597) and social studies (459). But the sciences in turn exceed international affairs (289), psychology (231), philosophy (186), religion (180) and government (128): biology alone provides more courses than philosophy, religion or government, and the physical sciences, with 167 courses, fall little short of religion. Given the inherent difficulties, which Prof. Peers does not fail to bring out, the position is less unsatisfactory than he suggests. Something must be allowed for variations in length of courses; but it remains remarkable that, in times like the present, international affairs should be less well represented. The student quoted by Prof. Peers who preferred "not to know the details" of the atom bomb that might blow her to pieces would seem to be as critical of international affairs as a subject of study. Here, perhaps, Prof. Peers's judgment is understandably coloured by the fact that his Department has a greater number of courses in international affairs than any other in the kingdom.

Nevertheless, Prof. Peers's approach is a sound one: "The real case for science as part of the general education of the adult citizen is exactly the same as the case for history, literature and the social sciences . . . without a knowledge of science he cannot live the best and most satisfying life of which he is capable: a whole range of experience, æsthetic as well as practical, is closed to him". This is well said, and the point is developed in some valuable paragraphs (pp. 6–7). It is doubtful, however, whether this view is sufficiently widely held in adult education circles. Prof. Peers quotes a science tutor's opinion as to the disadvantages caused by the unfamiliarity of organizers and administrators with science, only to brush it aside. He does not, however, seem to make sufficient allowance for the existence of latent demand. His argument that "it is not the business of Extra-mural Departments to use methods of persuasion to induce adult groups to choose one subject rather than another" begs the question, and reflects the conditions of an earlier period when 'demand' could be more easily recognized and satisfied. The task of the present in adult education, despite the great increase in the number of courses, is not to meet a recognizable and clamant demand, but to investigate society in order to ascertain where and how the universities, and other providers, can both stimulate and satisfy needs and interests. Prof. Peers offers some observations, based on the experience of several universities, on this aspect of the problem; but the investigation needs to be carried further and to be illustrated with actual syllabuses. His conclusion that little can be done "until science is given its proper place in the general curriculum of the schools" is open to question. Despite the arguments he offers, it is doubtful whether recollection of studies at school often encourages adult students

* Science in the Extra-Mural Work of Universities. By Prof. Robert Peers. Pp. 19. (Bristol: Universities Council for Adult Education, 1954.)

to attend courses in any subject. Nor is his criticism of "the absence of suitable text books" particularly valid, while his concern with "expensive microscopes and micro-projectors" as "a *sine qua non* of effective work" suggests a limited and specialist approach. It may be questioned, too, whether the claim that "the same objective methods" are used in the social sciences as in the physical can altogether be justified, while the criticism that the scientist is not necessarily dispassionate in his political or sociological judgments does not get us far: few of us would care to make even academic philosophers our kings.

Yet Prof. Peers offers some useful suggestions as to the development of courses in the sciences, and puts the subject in its proper perspective by proposing the establishment of science sub-departments of extra-mural departments, with the aim, above all, of achieving "the reintegration of science as an indispensable part of a liberal education". As a non-scientist he has rendered a valuable service in opening the subject for discussion: it is to the scientists in adult education that we now look for a more developed statement.

NUTRITION AND THE LIVER

SYMPOSIUM IN GLASGOW

ON May 8 the Scottish Group of the Nutrition Society held a symposium on "Nutrition and the Liver" in the Biochemistry Department of the University of Glasgow under the chairmanship of Prof. J. N. Davidson, head of the Department. This meeting provided an opportunity for workers in fields ranging from academic biochemistry to clinical medicine to pool their knowledge. Prof. Davidson introduced the subject with a short paper entitled "The Chemical Architecture of the Liver Cell", in which he described the technique of differential centrifugation, by means of which liver cells may be separated into a nuclear fraction, mitochondria, microsomes and the cell sap. He pointed out that mitochondria isolated in this way are morphologically different from mitochondria as seen in the living cell; furthermore, they are not a homogeneous population, since they can be subdivided into several chemically and enzymologically distinct fractions. The microsomal fraction is composed of minute particles, but these may represent the disintegration products of a reticulum in the cytoplasm of the living cell. Prof. Davidson then demonstrated that, although most chemical constituents of the liver are considerably affected by variations in nutritional status, the total amount of one component, deoxyribonucleic acid, remains unchanged even in the face of extreme dietary variations; the quantity of this component is determined solely by the number of cells present. Consequently, deoxyribonucleic acid can be used as a reference standard against which changes in other liver cell constituents can be measured. Examples were given of the misleading results which may be obtained when liver composition is expressed per 100 gm. of fresh tissue, and the clarification in interpretation which follows the expression of results in relation to deoxyribonucleic acid.

The influence of the protein and energy content of the diet on liver composition was considered by Dr. H. N. Munro (Department of Biochemistry, Glasgow). The amount of protein in the liver is considerably affected both by the level of protein and of energy intake. These changes in protein content occur much more rapidly and extensively in the liver than in most other tissues of the body. This has led to the supposition that the liver may contain a store of protein which is readily depleted under adverse nutritional conditions; but attempts to demonstrate a chemically discrete storage protein have not met with success. In parallel with changes in the protein content of the liver, there are also variations in ribonucleic acid and phospholipid content. These changes occur without any alteration in cell number, and the material so gained or lost has been named "labile liver cytoplasm" (Kosterlitz). By means of differential centrifugation of the liver into fractions, it has been shown that a reduction in protein intake causes a loss of protein from all parts of the liver cell, of ribonucleic acid principally from the microsomes, and of phospholipid from the microsomes and cell sap. Thus the material lost from various parts of the liver cell is not uniform in composition. Although the amount of ribonucleic acid is reduced by protein deficiency, its rate of synthesis seems to be independent of protein intake and to be determined by the level of energy intake. Dr. Munro concluded by suggesting that the failure to identify the labile protein of the liver with any single chemical or morphological entity within the liver cell could be readily explained if differences in the rates of protein synthesis in different tissues are considered. Such differences in rate will determine the speed with which these tissues adjust their protein content to altered dietary conditions. The liver, being among the most active in protein synthesis, will become rapidly adjusted, giving the impression of gaining or losing a labile protein component.

Dr. J. M. Naftalin (Rowett Research Institute) dealt with the production of liver necrosis in rats by dietary means. In summarizing the history of this subject, he pointed out that the two dietary conditions generally believed to be necessary for the production of liver necrosis are deficiency of sulphur-containing amino-acids and lack of vitamin E. His own investigations were aimed at determining the influence of restriction of food intake and of environmental temperature on the incidence of liver necrosis among animals receiving necrogenic diets. He observed that 70–78° F. (21·1–25·6° C.) is the optimal temperature for producing necrosis on diets deficient in vitamin E and low in sulphur-containing amino-acids, the incidence being considerably less at temperatures higher or lower than this. In addition, caloric restriction with the same diet reduces the frequency of necrosis. A sufficient degree of food restriction prevents liver necrosis at all environmental temperatures, but too severe restriction leads to death without necrosis. Variations in the incidence of necrosis also occur when different preparations of casein are used as the protein source in the necrogenic diet. The incidence of necrosis was found to depend on the origin of the casein and to be independent of alcohol–ether treatment used for the removal of vitamin contaminants. It is not yet known whether caseins differ in necrogenicity because of the presence of a toxic factor in the high-incidence preparations or of a protective factor in the low-incidence preparations.

Dr. E. Kodicek (Dunn Nutritional Laboratory, Cambridge) contributed a paper on the storage of vitamins in the liver which summarized much recent

work on the subject. He defined storage as the amount of a particular vitamin laid down in excess of the physiological level needed for normal functioning. From this point of view, the vitamins fall into two classes. The first group comprises those which occur in coenzymes or the prosthetic groups of enzymes, and for this group Dr. Kodicek proposed the name 'prosthetins'. Even with massive dosage, their concentration in the liver does not exceed a certain limit which probably represents saturation of the apoenzyme with the prosthetic group. Deficiency reduces the amount in the liver, but never to very low levels. These features are to be contrasted with the behaviour of the other group, the fat-soluble vitamins. Their concentration in the liver can be enormously increased by dosage (for example, to a hundred times the physiological level) or reduced to virtually zero by deficiency. The pattern of storage varies for the different fat-soluble vitamins. On dosage with vitamin A the efficiency of utilization can reach a maximum of 80 per cent of the amount fed, very high doses being toxic and leading to less efficient storage. By contrast, only a small fraction of administered vitamin D is stored in the body, most of it in the liver. Vitamin E is mainly found in the body fat; but dosage with this vitamin leads to a temporary increase in the liver concentration. It has recently been shown by Dam and his colleagues that deposition of vitamin K in the livers of chicks occurs only in response to dosage with the natural vitamin and not after administration of vitamin K substitutes; this may have therapeutic importance.

Dr. J. Waterlow (University College of the West Indies) described his experiences with disorders of the liver found in tropical countries in association with malnutrition. The chief forms of liver disease which are common in tropical climates are fatty liver and cirrhosis; massive necrosis is not more frequent than elsewhere. Fatty liver is found in very young children, and a severe form of fatty liver is a prominent feature of the kwashiorkor syndrome. The condition is nutritional in origin, probably the result of protein malnutrition in particular. In cases of fatty liver there is evidence of protein depletion, and Dr. Waterlow made the point that stigmata of protein insufficiency are not limited to the liver but are generalized, the organs most severely affected being those with the highest turnover of protein. Deposition of fat in the liver does not appear to be the fundamental factor determining the severity of the disease, which is probably dependent on the degree of protein depletion. The other common tropical liver condition, cirrhosis, does not appear to be an end-result of fatty infiltration, as has been demonstrated experimentally in rats. Geographically, there is little correspondence between the incidence of juvenile cirrhosis and of fatty livers in tropical countries. Dr. Waterlow suggested that juvenile cirrhosis may be produced by a combination of factors, one of which is malnutrition. Thus the occurrence of cirrhosis among West African children may result from a combination of malaria and malnutrition, the malnutrition being responsible for damage to the parenchymal cells and the malaria for overgrowth of fibrous tissue. In the West Indies the combination may be one of malnutrition and dietary toxins, arising from the widespread use of decoctions of plants ('bush tea').

The place of diet in the treatment of liver disease was discussed by Dr. A. L. Latner (Department of Chemical Pathology, Royal Victoria Infirmary, Newcastle upon Tyne), who described the nutritional principles underlying such treatment. He pointed out that, while a generous supply of protein in the diet is desirable for the regeneration of liver cells after the acute phase of liver damage is ended, the intravenous use of protein hydrolysates is irrational since the blood during severe liver damage already contains excessive amounts of amino-acids. There is, however, a good case for giving ample amounts of the vitamins. An interesting point made by Dr. Latner in this connexion was that the macrocytic anæmia associated with liver disease is relieved by folic acid but not by vitamin B_{12}. He also emphasized that liver diseases often cause profound disturbances of electrolyte metabolism which require correction. In acute liver failure Dr. Latner has obtained a high recovery rate by the intravenous use of glucose, saline, potassium chloride and massive doses of thiamine, nicotinamide and riboflavine, together with intramuscular injections of vitamins E and K. The dietetic treatment of some less acute forms of liver disease was also described.

Dr. A. J. Hale provided a microscopical demonstration of the minute anatomy of the liver for those attending the meeting. The communications will be published in the *Proceedings of the Nutrition Society*.

H. N. Munro

THIRD INTERNATIONAL RUBBER TECHNOLOGY CONFERENCE

The Third International Rubber Technology Conference, held in London at Church House, Westminster, during June 22–25, under the auspices of the Institution of the Rubber Industry, was attended by some six hundred and twenty delegates from eighteen countries. About seventy-five of the delegates were accompanied by their wives, for whom a separate social programme of visits to places of interest had been arranged.

In declaring the Conference open, its patron, the Marquess of Salisbury, who was introduced by the president of the Institution of the Rubber Industry, Lord Baillieu, welcomed the delegates on behalf of the British Government. He recalled that it was six years since the last Conference of this type, and that the matters to be discussed interested many parts of the world and would be concerned with such important matters as synthetic rubber, combinations of synthetic with natural rubber, and chemical modifications of natural rubber itself. After the official opening, the chair was taken by Dr. W. J. S. Naunton, the chairman of the Conference, who announced that there would be in all seven sessions, each having its sectional chairman, who would be a well-known authority on the subjects to be discussed. Fifty papers covering a wide range of subjects, some highly scientific and others purely technological, had been pre-printed and already circulated to the delegates. These papers had been selected from the ninety offered as being likely to provide a source of stimulating discussion.

The first session, under the chairmanship of Mr. E. A. Murphy, consisted of eight papers on the properties of natural rubber latex. The subjects discussed included the variability of *Hevea* latex, with

particular reference to differences in the phosphate/magnesium ratios of different clonal latices, and the structure of *Hevea* latex together with the influence of various chemical additives and treatments on its viscosity. Other papers dealt with the effect of various naturally occurring mineral elements on field latex; and with the destabilization of ammoniated latex and soap-stabilized emulsions in the presence of complex zinc diammine ions, which was suggested to be due to a decrease in hydration of the zinc diammine dilaurate, formed at the surface of the rubber particles. In an interesting paper E. W. Madge, H. M. Collier and J. L. M. Newnham described the study of viscosity changes in concentrated latex under different experimental conditions to determine the mechanism of the thickening of latex by zinc oxide. Small variations in the amount of natural soap have been found to be of great importance. Other papers described the peptizing of rubber by the addition of organic mercaptans to fresh latex, the production of improved rubbers by the enzymatic deproteinization of skim latex and the occurrence of microgel in latex and sheet rubber.

Two periods were devoted to the second session for the discussion of nine papers on synthetic rubbers, the chair being taken by Dr. Naunton himself. A paper which aroused much interest was one in which G. F. Bloomfield, F. M. Merrett, F. J. Popham and P. McL. Swift reported recent work on graft polymers derived from natural rubber, thus still further narrowing the gap between natural and synthetic rubbers and indicating how man may modify and sometimes improve naturally occurring high polymer hydrocarbons. A somewhat related paper by D. H. Coffey and T. J. Meyrick described the preparation and properties of condensation block copolymers of the polyester type. A paper entitled "How Synthetic Rubbers Affect You", by Mr. I. D. Patterson, described synthetic rubber progress in terms of a condensed time-scale and gave many interesting statistics of production and use, concluding with the apt quotation from Browning, "The best is yet to be". This paper provoked considerable discussion.

Prof. A. A. Morton, well known for his considerable work on the Wurtz reaction, presented a paper on the cation and anion influence in the 'Alfin' reagent for the polymerization of butadiene. He substantiated his remarks by producing from butadiene and 'Alfin' catalyst a piece of synthetic rubber having a molecular weight of about ten million, the whole procedure taking less than five minutes, and in full view of the audience. Among newer types of synthetic rubbers described were those derived from butadiene copolymerized with unsaturated ketones and with 2-methyl-5-vinylpyridine, the last-mentioned type being capable of cross-linking by a 'quaternizing' reaction with organic halides. Other papers dealt with such subjects as the structure and solution properties of butadiene styrene copolymers of high molecular weight and the oil resistance of synthetic rubbers over periods up to fourteen years.

The next session, under the chairmanship of Dr. L. C. Bateman, was concerned with the chemistry of rubber. Six papers were introduced by their authors and covered a wide field, including such subjects as particle surface reactions, vulcanization by sulphur linkage and by atomic energy radiation, oxygen absorption, and chemical reactions of antioxidants used in vulcanized rubber. A paper on infra-red spectroscopic analysis of elastomers was also discussed in this section.

In the session dealing with the physics of rubber, the chair was taken by Dr. J. R. Scott, and six papers were discussed, while in the case of two papers, the authors of which were not present, written comments or questions were invited. A wide variety of topics in this section included such subjects as permeability, reinforcement, elasticity, effect of nuclear magnetism, compounds for low-temperature service, elastic behaviour of filler-reinforced rubbers, dynamic properties and time-dependent effects in tyre cords.

The chairman for the session on developments in testing methods was Mr. J. M. Buist, and six papers were presented for comment and discussion. The first, by B. Pickup, described a new apparatus for assessing tear-down adhesion. E. F. Powell and S. W. Gough gave interesting information on the constant power principle in abrasion testing, while the paper by J. I. S. Williams and R. G. Clifton gave information on the methods of testing pneumatic tyres. Still other papers dealt with tyre cord fatigue, changes in electrical resistance with different black loadings, and a test for easily measuring the degree of vulcanization of rubber.

The sixth session (chairman, Dr. D. Parkinson) concerned itself with the theory and practice of compounding, and eight papers were delivered on many subjects, such as reinforcement by various means, oil-extending of natural rubber and the interaction of rubber and fillers during milling. As would be expected, several of the papers dealt with properties of various carbon blacks in rubber. An outstanding paper in this section was that by Dr. I. Drogin, who gave clearly and concisely a mass of detail on the properties of the various carbon blacks.

The final session dealt with miscellaneous technology, with Dr. J. G. Mackay taking the chair. Four papers all concerned with, or related to, tyres were grouped in this section, the individual titles being as follows: abraded filament tyre cords; effect of heat setting on the physical properties of 'Terylene'; wave phenomena in tyres at high speed; and tread wear and fuel consumption of tyres.

An exhibition of instruments, selected principally to show some of the developments in rubber testing which have taken place since the last Conference, in 1948, was arranged in conjunction with the present Conference, there being seventy-six items, arranged in twelve groups. The organizations responsible for the development and manufacture of the instruments were indicated in the exhibition catalogue, and references to the literature were also given. In many cases, where appropriate, the instruments could be operated by turning a switch. The exhibition also contained a display of samples made from modified natural rubber, and a stand showing recent books dealing with rubber science and technology. Mr. B. J. A. Martin, who was responsible for the organization and arrangements of this exhibition, is to be highly commended for a most successful and interesting display. The proceedings of the Conference are to be published as a single volume, and the important task of collecting the many papers and discussions is in the capable hands of the editor-in-chief, Mr. T. H. Messenger. There is no doubt that this volume, when issued, will form a valuable record of the 1954 Rubber Technology Conference.

F. A. Jones

STANFORD RESEARCH INSTITUTE, CALIFORNIA

REPORT FOR 1953

THE report for 1953 of the Stanford Research Institute, California*, states that contract research at the Institute increased by 18 per cent to 6·5 million dollars, the percentage of government research declined from 61 per cent in the first quarter to 49 per cent at the end of the year, while industrial research projects increased by 7·9 per cent on 1952 and 78·5 per cent on 1951. Of the 382 projects carried on during the year, 234 were for commercial clients and 109 for government agencies, while 39 studies were initiated or continued by the Institute as part of its plan for aiding the technological development of the region. Some 9 per cent of the Institute's revenue during the past three years has been expended on international activities, while a 30 per cent expansion in staff brought the total to 674 at the end of the year, the increase in professional staff in 1953 being 126.

The present research programmes are in physical and biological sciences, engineering, economics, and certain applications of industrial psychology and sociology. Much effort in 1953 was directed towards the automatic assembly of equipment, control of processes and handling of large amounts of standardized data. Automatic processing and control were applied to a number of instruments, and a major programme was concerned with the development of improved machines and methods for the automatic fabrication of electronic equipment. A preliminary exploration of the possibility of constructing an input–output table for the flow of goods and services in the economy of the eleven western States of the United States was initiated, as well as a study of the impact of the aluminium industry on the economy of the Pacific North-West. A continuous process in which sawdust is held in fluidized suspension in a reactor is facilitating the preparation of chemicals from wood waste, while new lubricants for application at high temperatures have been developed experimentally and the physical properties of moulding resins were being correlated with structure to permit the preparation of new products with the desired combination of properties. A fundamental study of shock-wave behaviour in solid materials has led to a continuing programme on the application of the general laws of explosive shock waves to specific problems.

Another study is concerned with systematizing the use of selected common weeds as indicators of atmospheric pollution, while several field studies were concerned with the nature of the damage to commercial crops and vegetation by fluorides. A new instrument has been developed, utilizing a tape impregnated with a substance that loses its fluorescence on contact with gaseous fluorides, which gives an accurate record of atmospheric fluorides. Tracer techniques have made it possible to determine the contribution made by contaminants from a particular source to the total atmospheric contaminants in a given area. An extensive study of the requirements for airborne antennæ used in a long-range air-to-ground communications on military aircraft was completed during the year, while the Institute continued to participate in the application of operational research techniques both in defence problems and in industrial problems. Besides the development of new research techniques and instruments, the Institute has organized a techno-economic approach for assessing quickly the potential prospects of new products and markets.

* Stanford Research Institute. Annual Report. Pp. 48. (Stanford, Calif.: Stanford Research Institute, 1954.)

CHEMICAL RESEARCH LABORATORY, TEDDINGTON

REPORT FOR 1953

THE report of the Chemistry Research Board, signed by the chairman, Prof. E. L. Hirst, and the report of the director of the Chemical Research Laboratory, Teddington, Dr. D. D. Pratt, comprise the publication entitled "Chemistry Research 1953"*, which has recently appeared. To these are appended lists of committees of the Board, of staff of the Laboratory on December 31, 1953, of publications and patents in 1953, of metals held by the Pure Metals Committee, of standard substances available and of species in the National Collection of Industrial Bacteria. During the year the Chemistry Research Board endorsed a recommendation that chemical engineering should be added to the programme of the Laboratory, and, although such activities are at present planned on a modest scale, the Board points out that considerable additions to staff and accommodation will be required. The Board has also endorsed the recommendation of the Microbiology Committee that the Laboratory should pursue its investigations on the microbiological production of sulphur using sewage sludge as source of carbon as far as laboratory large-scale experiments to provide data for pilot-plant operation, and experiments have also been made on the simultaneous production of carbon and methane, which should offer considerable savings in capital and operating costs.

Commenting on the provision of standard materials by the Laboratory, the director points out that, since the National Collection of Industrial Bacteria was formed in 1950, 2,505 cultures have been distributed; and, of the 814 distributed in 1953, 535 were to research and educational and 279 to industrial establishments. Some effort is now being devoted to research on the maintenance of these cultures, particularly with reference to the viability of the organisms under freeze-drying conditions. The Laboratory has now forty-one reference specimens of organic compounds available, including five added during the year, and supplied 355 samples compared with 256 in 1952. The Board regards this work as a most valuable contribution to the nation's scientific work. A stock of twenty-six pure metals is also maintained, and the Pure Metals Committee has noted, as a result of scientific developments in the field of semi-conductors, a growing demand for metals of a much higher degree of purity (99·999 per cent). Among the advisory work of the Laboratory, the director's report specially mentions that on immersed corrosion, underground corrosion and atmospheric corrosion in which services have been rendered to industrial firms and public bodies in

* Department of Scientific and Industrial Research. Report of the Chemistry Research Board with the Report of the Director of the Chemical Research Laboratory, for the year 1953. Pp. iv+73. (London: H.M.S.O., 1954.) 2s. 6d. net.

Britain, the Middle East, South and East Africa and elsewhere. Samples of organic compounds have been analysed for some eighteen firms by infra-red spectrometry; in radiochemistry some twenty firms were assisted by the Radiochemical Group, and the Microbiology Group gave advice on problems connected with sulphate-reducing bacteria to many authorities including county and urban councils, stations of the Department of Scientific and Industrial Research and industry. The director's report notes that an increasing proportion of the time of the Corrosion of Metals Group is given to such extra-mural *ad hoc* problems. Apart from this, the Group has continued its study of the mechanism of corrosion inhibition, using mild steel immersed in potassium chromate solutions labelled with chromium. The capacitance method of evaluating the water uptake of paint films has been applied to coatings on nickel immersed in sea-water, and the test possesses advantages of speed, simplicity, continuity and non-destructiveness; but there appears to be no clear relation between the type of paint formulation and the degree of agreement with values obtained by the gravimetric method; for some paints and media agreement is close, whereas for others the values differed markedly. The Group is also investigating the corrosion of mild steel tubes in Scotch marine boilers; but its advisory work has limited its laboratory work largely to underground and microbiological corrosion and to examinations of corroded pipes, electrical power cables and soil samples, although it has been shown that mild oxidation increases the toxicity of commercially available tannins towards sulphate-reducing bacteria, and an explanation has been advanced of the formation of the geological deposits consisting of clay, sand or gravel cemented by iron oxides into a hard mass known as iron pan. An investigation of the oxidation of mild-steel sheet at 200° C. has thrown light on the mechanism of oxidation and on other phenomena at that temperature. Following further tests, the Becker-type condensation apparatus has been recommended to the parent committee of the Institute of Petroleum as a standard test for the evaluation of temporary protectives, and an apparatus embodying the same principle but capable of testing more and larger specimens has been designed at the request of the British Standards Institution.

The work of the Inorganic Group has been concentrated on the examination of waste and low-grade materials for the presence and recovery of valuable constituents and the preparation of elements and derivatives to a high degree of purity. The search for selenium in waste products continued, and, in view of difficulties experienced in obtaining consistent analytical results, much effort was given to securing analytical procedures more applicable to the variety of products and their wide range of selenium content. A method has been developed for the determination of small amounts of phosphorus in vanadium concentrates based on volatilization of the vanadium as vanadyl trichloride by heating at 420° C. in a slow stream of dry hydrogen chloride. Other work has been concerned with the recovery of sulphur from low-grade sulphur ores and of copper from flash-roasted pyrites cinders, while concentration studies have related to the behaviour of gold and other metals in adsorption and elution from 'Amberlite IRA 400', the behaviour of molybdate, chromate, vanadate, arsenate and tungstate with basic resins and the evaluation of new ion-exchange resins for separating metals. A chromatographic separation process for niobium, tantalum, copper, cobalt, uranium and lead in soils, for use in the field, the operation being completed in less than thirty minutes, has been designed, and the partition of thorium nitrate between ether and water at varying concentrations of thorium nitrate and nitric acid has been determined. A scintillation counter for use with carbon compounds containing carbon-14 has been completed and tested, as well as an apparatus for testing the behaviour of ion-exchange resins under repeated treatment with a series of solutions.

In the Organic Chemistry Group vapour-pressure and boiling-point measurements on phenol have nearly been completed, and the densities at 20° C. and 30° C. of pyridine and of four of its homologues have been determined, as well as the refractive indices of fourteen mixtures of pyridine and water, thus permitting the analysis of such mixtures with high precision from refractive index measurements. This system has also been re-examined over the whole range of concentrations with a vapour–liquid equilibrium still, operated isothermally, at 70° C. and at 90° C. Results of a combined investigation with the National Physical Laboratory of the construction, use and long-term behaviour of triple-point water cells indicate that the triple point of water is reproducible to 0·0001 deg. C. and that the triple-point cells do not deteriorate even after several years of use. Preparative work has been concerned mainly with carboxylation by means of carbon dioxide, particularly of phenols and of epoxides; the preparation and applications of isotopically labelled carbon compounds; and the exploration of new ion-exchange resins containing chelating groups. Under the first, a brief study of 4-hydroxy*iso*phthalic acid has indicated a tendency for the carboxyl group to be eliminated in substitution reactions, and high yields of ethylene carbonate have been obtained from carbon dioxide and ethylene oxide under pressure in the presence of catalysts. Sulphur dioxide similarly yielded a linear polymeric sulphate, depolymerized to the cyclic monomer on heating, while ethylene oxide and phosgene give by exothermal reaction, first, β-chloroethyl chloroformate, which with more ethylene oxide yields di-β-chloroethyl carbonate. Work continued on the preparation of resins containing complex-forming functional groups, from formaldehyde and resorcinol derivatives, while the Arbuzov reaction has been used to prepare ion-exchange resins containing the phosphonic acid group. The randomization of carbon-14 in methylcyclohexane has been developed into a useful method for the synthesis of labelled aromatic compounds, and the technique of filling ampoules with gases or liquids has been developed and a Podbielniak fractional distillation unit installed.

The High Polymers Group concentrated its effort on ion-exchange and allied properties of cross-linked polymers and semi-permeable membranes, and their applications. A detailed study of the relative affinities of alkali metal cations for sulphonated polystyrenes of different cross-linking has been completed, but no further work on strongly acidic cation-exchangers is proposed. By chloromethylation of styrene – divinylbenzene copolymers and subsequent animation in dioxan, methyl ethyl ketone or benzene, a range of anion-exchange resins has been prepared the properties of which may be systematically varied with respect to functional group, degree of cross-linking and ion-exchange capacity. Work has also continued on

resins containing chelating groups, and a study of factors determining the semi-permeability of poly (vinyl alcohol) films in non-aqueous systems has shown that membranes of low permeability can be used to determine the molecular weights of simple compounds of known structure; work on the development of membranes for use in aqueous systems has commenced.

Besides the work already noted, the Microbiology Group continued its fundamental studies of sulphate-reducing bacteria, particularly their metabolism, and the continuous process for bacterial sulphate reduction, and started some studies of the bacterial oxidation of aromatic compounds, particularly the microbiological breakdown of phthalate, a process of industrial importance in the disposal of effluents.

THE ICE AGES AND PAST VARIATIONS OF THE EARTH'S CLIMATE

DURING the past sixteen years, Dr. E. J. Öpik has written extensively on climatic changes in a number of publications, and in Contribution No. 9 of Armagh Observatory, entitled "A Climatological and Astronomical Interpretation of the Ice Ages and of the Past Variations of Terrestrial Climate"*, he has written a paper which largely embodies the main points in his studies.

As might be expected, Dr. Öpik rejects the old astronomical theories of the fluctuations of climate—the changes in the obliquity of the ecliptic and the eccentricity of the earth's orbit. About half a century ago these were shown to be utterly inadequate to account for glaciations and warm interglacial climates, but from time to time they have been revived. Simpson's theory of the ice ages, which was advocated a quarter of a century ago—that they are caused primarily by an increase in solar radiation which in turn leads to a rise of the mean global temperature and an increase of the absolute moisture content of the atmosphere, followed by more precipitation in the form of snow in the polar regions and an advance of glaciers—is dismissed with very little criticism. It is pointed out that there is an absurdity in the theory which postulates the melting of the glaciers and the retreat of the ice when the greater heat takes control, because both the advance and the retreat of the glaciers are explained by the same cause. In addition, climatological and other evidence points to the conclusion that the glaciers of Greenland retreated during the past century, in close response to the increased global temperature.

Dr. Öpik maintains that an interpretation of climatic changes cannot be made without a clear quantitative understanding of the heat balance of the earth, and he develops a method of quantitative analysis of the climatic heat balance, based on the equation $Q = I + E$. In this, Q, I and E represent respectively the net radiation to space, the net insolation or the absorbed solar radiation, and the heat supplied by other sources; the last-named includes convective interchanges with other parts of the earth's surface, such as atmospheric and oceanic currents, or released from that stored in the soil, the water or the atmosphere. On this basis and with certain further assumptions, standard mean radiation curves, in dependence on the mean surface temperature, are calculated for summer and winter as well as for clear and cloudy sky, and the results are given in the paper. Two sections, comprising twenty pages, are devoted to "Variations of Solar Luminosity" and "The Mechanism of Solar Long-Term Variability" and contain references to Öpik's work on these problems during the past fifteen years or more. Regarding the latter section, it appears that a temporary increase of the energy production near the sun's centre will lead to a decrease of solar radiation and to an ice age if the decrease is deep enough. A qualitative picture is sketched of the way in which repeated disturbances in the interior of a dwarf star like the sun can be produced, and it is just possible that here may be an explanation of the mechanism by which major ice ages were recurrent phenomena of a periodicity of about 240 million years. Of course, there is necessarily a considerable amount of speculation in all this, and it is very difficult to make many definite deductions in such matters.

Towards the end of the paper, under "The Problems of Pre-Tertiary Climate", Dr. Öpik confirms his views expressed in 1938 that, although Wegner's theory of continental drift, postulating a corresponding displacement in latitude, cannot explain the last ice age, nevertheless there can be little doubt about the reality of large-scale horizontal displacements (Alpine foldings) in the earth's crust. The opinion is expressed that even if the strange phenomena of Carbo-Permian glaciation can be partly explained by continental drift (and this glaciation is an inducement to regard Wegner's theory favourably), this explanation completely fails for the earlier Cambrian glaciation.

* Contributions from the Armagh Observatory, No. 9: A Climatological and Astronomical Interpretation of the Ice Ages and of the Past Variations of Terrestrial Climate. By E. J. Öpik. Pp. 79 (distributed by Blackwell Scientific Publications, Ltd., Oxford, 1953). 10s. 6d. net.

WINCHESTER COLLEGE NATURAL HISTORY SOCIETY

IT is regrettable that the reports of the Winchester College Natural History Society can be published only once every three years owing to increased costs of printing, etc., for the report before us (1950–53) is well produced and makes very encouraging reading. However, duplicated summaries of observations on birds, insects and plants are issued every year.

The Society itself is very active, and the report reveals a variety of interests from general field observations to more specialized studies. Three specialized sections of the Society have now been formed—birds, insects and plants—and others may follow.

The report opens with an account by the warden, J. A. L. Myres, of the Viscount Grey Nature Reserve, "Fallodon", which is a part of Watermeads, a piece of land belonging to the College. It is quite clear that enthusiastic boys of the College have done much to render this nature reserve a really valuable asset since the War, during which its upkeep proved impossible.

P. J. Chadder gives an excellent account of the birds' nests (fifteen nests of seven different species) he examined in Fallodon during 1953. This is followed by a numerical analysis of the seasonal changes in birds in that reserve by D. E. D. Campbell.

He concluded that the number of birds were the same in summer as in winter, but that there were considerable decreases during early spring and autumn. The population also varied from week to week during the winter, but was constant during the summer. H. E. Norton publishes a commendable study of the territorial life of the blackbird—a long paper accompanied by six maps. He also presents the bird records for September 1949–July 1953. The bird-ringing report is made by J. A. L. Myres. Interest in birds is also enhanced in this report by a short account of the birds of Australia by J. E. Mollison.

A record of butterflies and moths around Winchester during 1950–53 is given by P. O'B. Harris. W. H. Dowdeswell describes the numerous visits made to Fisher's Pond, a pond which is proving ideal for the study of freshwater life. Molluscs, arthropods and birds were the main subjects of investigation. Another long paper is contributed by R. G. Borneman, writing on the movements and changes in a freshwater plankton community. This is accompanied by two figures and a table of results. Botanical activities are recorded by J. B. Poynton.

During the season reported about forty lectures and film exhibitions were arranged.

This report is one of several which reveal the active interest shown in some schools in field natural history where young students are able to make first-hand studies in ecology, taxonomy, behaviour, etc. Winchester College, with some of our more enthusiastic schools, is leading the way in a fuller appreciation of the true import and value of biological studies.

FORESTRY IN NEW ZEALAND

THE critical position of the indigenous forests of New Zealand has been known for some years and discussed in the annual reports of the Director of Forestry, New Zealand Forest Service. The annual report for the year April 1952–March 1953 (pp. 80. Wellington: New Zealand Forest Service, 1953) deals at some length in its opening pages with this question in its relation to the large area of exotic softwood coniferous forests now existing in the Islands. The position appears to be whether to sanction cutting out in a comparatively few years the remaining existing indigenous forest to maintain the saw-mill industry and industries dependent on indigenous timber and other vested interests, or to reduce the cut so as to maintain a portion at least of the natural forest of the Islands. The Forest Service correctly advocates the latter policy; but there appears to be a considerable body of public opinion against it.

New Zealand is not the only country in the world faced with this question in varying aspects, not excluding Great Britain. The time would appear to be approaching, if indeed it has not been already reached, when the world as a whole will have to make up its mind so far as forestry is concerned (which, in fact, is Nature herself) whether the forest soils of any country capable of maintaining its indigenous forest and species of trees should not rigidly be confined to this purpose; fast-growing exotics showing quick financial returns would then only be used when obviously useful or to fill a temporary gap in supplies, due to past mismanagement by man of the natural forests.

In New Zealand, as the report says, "The exotic forests were established to conserve the indigenous forests; therefore it is putting the cart before the horse to suggest that the Forest Service is seeking a ready sale for exotics by curtailing the cutting of native timber. It would be more correct to say that the production of exotics has been expanded in order to make it possible to reduce the sale of indigenous timber. . . . Experience has shown in foreign countries . . . that exotic species have definite limitations and for this reason the national policy must envisage the management of the indigenous forest to secure their maximum favourable production of timber". To this might have been added their management by the Forest Service in perpetuity, since there can be no question that this is the correct forest and economic policy for the indigenous forests.

E. P. STEBBING

NEW OBSERVATIONS ON THE CHEMISTRY OF N-CARBOXY-ALPHA-AMINO-ACID ANHYDRIDES

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THE polymerization of N-carboxy-α-amino-acid anhydrides initiated by primary and secondary bases has been studied in some detail, and the main features of the chemistry of the reactions occurring are fairly well understood[1]. In these cases the main products are linear polypeptides. When primary or secondary base initiation has not been used, other products have occasionally been observed, including cyclic peptides and substituted derivatives of hydantoin 3-acetic acid[2,3]. The exact experimental conditions favouring the formation of these substances are not established in the literature, and no detailed mechanism of the reactions has been put forward. We have recently investigated the behaviour of a number of N-carboxy-α-amino-acid anhydrides in highly polar organic media, and have observed some interesting phenomena which lead to a clearer understanding of the general chemistry of these compounds. Our main observations, on the effects produced by the addition of inorganic salts and tertiary bases, are summarized here.

Catalysis by Inorganic Salts

Many N-carboxy-α-amino-acid anhydrides are stable, or react only slowly when dissolved in highly polar organic liquids such as NN-dimethylformamide or NN-dimethylacetamide. Addition of a soluble anhydrous inorganic salt, however, has been found to produce a rapid reaction. Fig. 1 shows typical results with glycine, C-phenyl glycine and DL-phenylalanine N-carbonic anhydrides in NN-dimethylformamide. In the case of C-phenyl glycine N-carbonic anhydride there was no detectable reaction before the addition of lithium chloride; after addition, rapid evolution of carbon dioxide occurred. Glycine and DL-phenylalanine N-carbonic anhydrides gave

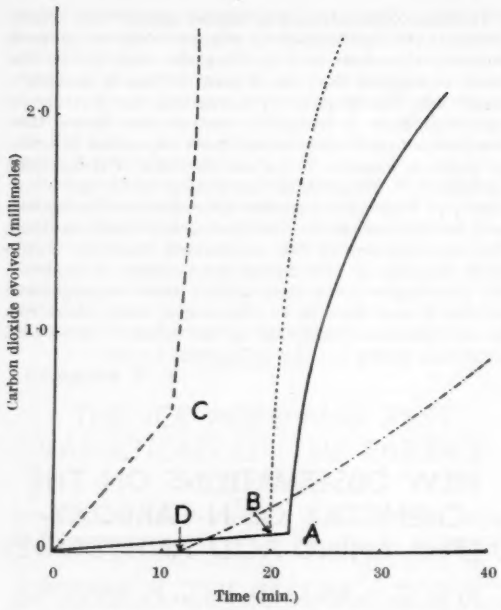


Fig. 1. Salt-catalysed reactions in N : N-dimethylformamide solution

———, Glycine N-carbonic anhydride (8 millimoles) in dimethylformamide (10 c.c.) at 50° C. Sodium iodide (3 c.c. of a 0·8 *M* solution in dimethylformamide) added at *A*

- - - - - -, Glycine N-carbonic anhydride (8 millimoles) in dimethylformamide (10 c.c.) at 50° C. Lithium chloride (25 millimoles) added at *B*

— — —, DL-Phenylalanine N-carbonic anhydride (8 millimoles) in dimethylformamide (10 c.c.) at 27° C. Lithium chloride (25 millimoles) added at *C*

– · – · – · –, DL-C-Phenyl glycine N-carbonic anhydride (10 millimoles) in dimethylformamide (10 c.c.) at 50° C. Lithium chloride (25 millimoles) added at *D*

measurable reaction-rates in the absence of salts, but these were accelerated by factors up to 200 on addition of lithium chloride or sodium iodide.

Examination of the liquids after reaction revealed that the main products are cyclic polypeptides and derivatives of hydantoin 3-acetic acid corresponding to the anhydride used. Table 1 gives representative results for the yields of the hydantoin derivatives; the remainder of the anhydride forms mainly cyclic peptides. No 2 : 5-diketopiperazines have been identified. With glycine, the hydantoin 3-acetic acid (V) was estimated colorimetrically with alkaline picric acid and by titration, the two methods giving concordant results. For the other anhydrides the results given are based on titration results only, and would therefore include other compounds containing —COOH, for example, carboxyl-terminated polymers containing ureido groups. As may be seen from Table 1, the yield of the hydantoin derivative may be considerable.

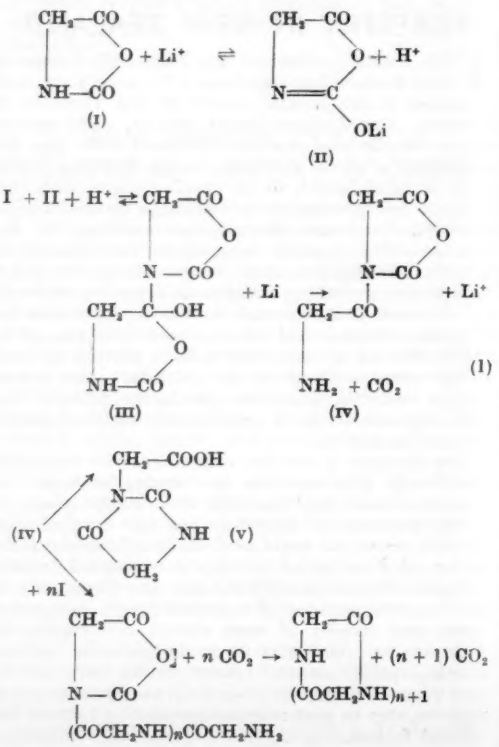
A brief study of the main kinetic features of the lithium chloride catalysed reactions of glycine N-carbonic anhydride has been made. The initial rate of reaction is not affected significantly by the presence of water, and does not depend upon the method adopted for purifying the salt. Acids have a strong inhibitory effect on the reaction, this being particularly marked at the lower salt concentrations. A trace of acid present initially produces an induction period. The hydantoin 3-acetic acid produced is a

Table 1. Salt-catalysed Reactions in NN-Dimethylformamide Solution

N-Carbonic anhydride of	Initial concentration (mol.l.$^{-1}$)	Salt concentration (mol.l.$^{-1}$)	T °C.	Per cent of anhydride converted to hydantoin 3-acetic acid
Glycine	0·53	$1·6 \times 10^{-2}$ (LiCl)	27	7·6
,,	0·17	,,	27	11·2
,,	0·52	$1·6 \times 10^{-2}$ (LiCl)	27	10·2
,,	0·08	,,	27	17·4
,,	0·6	2·5 (LiCl)	50	30
,,	1·0	0·8 (NaI)	50	30
C-Phenyl glycine	1·0	2·5 (LiCl)	50	40
DL-Phenyl-alanine	1·0	,,	50	17

comparatively strong acid ($pK_a \sim 3$), so that the reaction is self-inhibiting at quite small conversions. At salt concentrations greater than 0·1 *N* the rate shows second-order dependence on monomer concentration, and is independent of the concentration of lithium chloride. The rate falls off with decreasing concentration of lithium chloride below about 0·1 *N*.

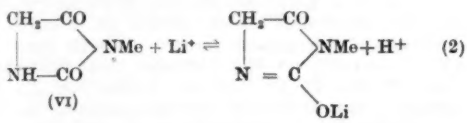
The catalytic effect of salts is apparently connected with the presence of an —NH— group in the N-carbonic anhydride molecule. N-methyl glycine N-carbonic anhydride (sarcosine N-carbonic anhydride) does not react when dissolved in NN-dimethyl-formamide–lithium chloride mixtures, but a rapid reaction ensues if 3-methyl hydantoin (VI) is added. This latter substance has structural similarities with glycine N-carbonic anhydride and probably interacts with lithium salts in an analogous manner. The products of this reaction are then



capable of initiating the polymerization of the sarcosine N-carbonic anhydride. The overall reaction yields polypeptides with basic groups, which titrate like those in linear polysarcosines. This reaction, like that of the glycine N-carbonic anhydride, is powerfully inhibited by traces of acids.

We consider that the catalytic effect of salts such as lithium chloride is to be attributed to complex formation between the anhydride, or hydantoin, and the cation, resulting in the displacement of a proton and the formation of a molecule in which the nitrogen atom has basic properties sufficient to allow reaction with N-carboxy-α-amino-acid anhydrides. Thus the reactions with glycine N-carbonic anhydride (I) may be envisaged as shown in scheme (1).

These reactions may be shown to be consistent with the kinetic observations. An important feature of the mechanism is that the formation of hydantoin 3-acetic acid and cyclic polyglycine from (IV) is accomplished without postulating improbable cyclizations. A study of models of (IV) shows that production of 2 : 5-diketopiperazine by direct cyclization is most unlikely and, as we have already mentioned, this compound does not seem to be formed. The primary reactions of sarcosine N-carbonic anhydride in the presence of lithium chloride and 3-methyl hydantoin are probably similar, the first step, (2), being followed by formation of compounds analogous to (III) and (IV):



(2)

It is interesting to note that a cyclic structure is necessary for initiation of this kind; the open-chain analogue of (VI)—acetyl *sym*-dimethyl urea—is ineffective.

Since the reaction-rate is independent of the concentration of lithium chloride, the exact nature of the ionic species reacting with the N-carbonic anhydride is uncertain; this may be an ion pair such as Li^+Cl^- or a partly or wholly solvated cation.

Catalysis by Tertiary Bases

N-carboxy-α-amino-acid anhydrides which are not N-substituted appear to react readily in the presence of tertiary bases, particularly in polar media. Again, the products contain considerable amounts of hydantoin 3-acetic acid derivatives, as shown in Table 2.

Table 2. REACTIONS CATALYSED BY TERTIARY BASES. 27° C.

N-Carbonic anhydride of	Solvent	Per cent anhydride converted to hydantoin 3-acetic acid derivative
Glycine	NN-Dimethylformamide	60
"	Nitrobenzene	8
"	Acetonitrile	28
* "	Pyridine	2
* "	NN-Dimethylformamide + 10 % pyridine	40
C-Phenyl glycine	NN-Dimethylformamide	17
DL-Leucine	"	25
DL-Phenylalanine	"	16

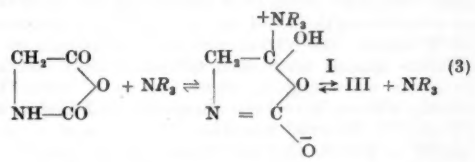
Initial concentration of the anhydride was 0·2 *M*; the initiator was triethylamine in concentration 0·008 *M*, except where marked *, when no triethylamine was added

The only other major products are cyclic peptides, which in the case of glycine N-carbonic anhydride have been isolated in crystalline form. Of these, cyclic hexaglycine predominates. No 2 : 5-diketopiperazine has been detected.

The relative yields of hydantoin derivative and cyclic peptide clearly depend on the nature of the solvent. One important factor is the polarity of the latter, as shown by a comparison of the two experiments with pyridine given in Table 2. A high polarity favours hydantoin formation; but the results with dimethylformamide and nitrobenzene show that other factors are also involved.

No reaction has been observed in any solvent between pure sarcosine N-carbonic anhydride and tertiary bases. This is in sharp contrast to the results obtained by Wessely and co-workers[3]; we have been unable to confirm the claims made by these authors that N-substituted N-carboxy-α-amino-acid anhydrides react readily in pure pyridine.

The results obtained with tertiary bases obviously resemble those with lithium salts in polar media, and a corresponding mechanism may be postulated. For example, equilibria such as those shown in (3) may exist, leading to reactions analogous to those in (1):



(3)

Essentially similar mechanisms leading to the intermediate formation of the dimer (III) may be proposed for the spontaneous decomposition of N-carboxy-α-amino-acid anhydrides in polar organic solvents. (The formation of high polymers in non-polar solvents probably results from initiation by traces of water or other impurities.) We have observed that the presence of traces of water leads to an increase in the proportion of hydantoin 3-acetic acid formed during the decomposition of the glycine N-carbonic anhydride in dimethylformamide. With larger amounts of water, however, hydantoin formation decreases until in pure water or in aqueous lithium bromide solution no hydantoin-3-acetic acid is formed. Thus in the presence of high concentrations of water, normal initiation by the latter appears to predominate. Parallel results are obtained with the lower aliphatic alcohols, hydantoin 3-acetic acid when formed appearing as the free acid and not as the ester. This latter observation is consistent with our mechanism for the spontaneous decomposition of the N-carboxy-α-amino-acid anhydrides, which is probably operative under these conditions.

To summarize, we consider that the nitrogen atom of an N-carboxy-α-amino-acid anhydride may in some circumstances assume basic properties without rupture of the heterocyclic ring. This leads to a variety of reactions which are of predominant importance in highly polar media, and which may also account for the minor products observed under different conditions by other workers. [March 8.

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LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Radio Observations of Ionized Hydrogen Nebulæ and Other Discrete Sources at a Wave-length of 9·4 cm.

In recent attempts[1–3] to account for the general radio emission from the Galaxy as the integrated radiation of discrete galactic radio sources, it was found necessary to introduce the effect of ionized interstellar hydrogen, H II regions, to fit the observed radio isophotes at various frequencies. Scheuer and Ryle[4] detected, at wave-lengths of 1·4 and 3·7 m., a bright band of emission confined within 2° of the galactic equator superimposed on the general radiation. They identified the bright band with thermal emission from a distribution of H II regions. H II regions are strongly concentrated in the galactic plane. The large source, Cygnus X, has been tentatively described as thermal emission[5], perhaps from several bright H II regions surrounding γ Cygni[3], or from the integrated radiation of all the H II regions in the spiral arm in the direction of Cygnus[3]. However, Baldwin[6] attempted unsuccessfully to detect, at a wave-length of 1·4 m., a very bright individual H II region, the Orion nebula. Observations of discrete sources have been almost entirely confined to metre wave-lengths, where spectra of more than twenty sources have been obtained[7]. Piddington and Minnett[5,8] observed five discrete sources at a wave-length of 25 cm. and the emission at 25 and 10 cm. from a region near the galactic centre. This was an appreciable extension of the short-wave limit of source spectra.

We recently reported[9] the further extension, to a wave-length of 9·4 cm., of the spectra of six well-known sources and the detection of four bright galactic nebulæ: the Orion, Omega, Trifid and Lagoon nebulæ, bright individual H II regions. Diffuse nebulæ had not been previously identified as radio sources. Evidence was given for the thermal origin of the observed radiation from the Orion nebula, thereby supporting the assumption of thermal emission from a distribution of H II regions. Recent measurements[10] at a wave-length of 21 cm. by Hagen, McClain and Hepburn have been made on the Orion nebula and several other H II regions. The Orion nebula flux density was, as predicted by the thermal model, the same as that observed at a wave-length of 9·4 cm.

This communication reports a second survey at wave-length 9·4 cm. undertaken during March 10–18, 1954, principally of known H II regions[11]. The 50-ft. diameter paraboloidal reflector[12] and microwave radiometer was again employed. The antenna beam was 0·45° × 0·40° between half-intensity points. Table 1 summarizes preliminary results of both surveys. The estimated accuracy of the antenna temperature, T_A, is 2° K. and of the flux density 25 per cent. The brightness temperature of a source averaged over the beam equals 1·7 T_A. The positions of sources are estimated to be accurate to 0·2 min. in R.A. and 5′ in Dec. for the first eight sources and to 1 min. in R.A. and 15 in Dec. for the remainder, except for the large sources which subtend about 2° (Nos. 9, 16, 21 and 24). The N.G.C. number gives the New General Catalogue, or Index Catalogue, number of the celestial object previously identified with or suggested here as the radio source. Messier objects are also numbered.

Sources Nos. 1–11 were detected in the first survey[9] and were mentioned above. Source No. 5 lies in the direction of the galactic centre (galactic longitude 327·6°, latitude −1·46°). Further measurements of Nos. 10 and 11 give revised values for T_A and indicate that they are discrete sources, perhaps superimposed on radiation from the galactic plane. Source No. 12 also appears to be superimposed upon radiation from the galactic plane. No. 24 was obtained from a drift of the galactic plane through the antenna beam. These findings indicate that a narrow band of galactic radiation at wave-length 9·4 cm. extends at least 10° along the galactic plane through the galactic centre (No. 9) where it is brightest. This may be identified with the bright

Table 1. Radio Sources observed at 9·4-cm. Wave-length

No.	Constellation	T_A (°K.)	Flux density* (watt. m.$^{-2}$ (c./s.)$^{-1}$ × 10^{-25})	R.A. (1950) h. m.	Dec. (1950) ° ′	N.G.C. number	Remarks
1	Cassiopeia	53	150	23 21·3	58 32	—	Unusual galactic nebulosity†
2	Taurus	28	80	05 31·4	21 54	1952	*M*1, Crab Nebula, supernova remnant†
3	Cygnus	25	70	19 57·8	40 34·5	—	Colliding galaxies†
4	Sagittarius	24	68	18 17·9	−16 14	6618	*M*17, Omega Nebula‡
5	Sagittarius	17	48	17 42·5	−29 01	—	Unidentified, near galactic centre§
6	Orion	16	45	05 33	−05 27	1976	*M*42, Orion Nebula‡
7	Centaurus	7	20	13 22·1	−42 50	5128	Unusual galaxy†
8	Virgo	5	14	12 28·2	12 37·5	4486	*M*87, unusual galaxy†
9	Sagittarius	6	—	17 42·5	−29 00	—	Galactic background under No. 5‡
10	Sagittarius	4	11	17 59	−23 02	6514	*M*20, Trifid Nebula‡, revised values
11	Sagittarius	7	20	18 01	−24 23	6523	*M*8, Lagoon Nebula‡, revised values
12	Scorpius	14	40	17 22	−34 09	6357	Contains a Wolf-Rayet star‡
13	Scorpius	9	25	17 17	−36 00	6334	‡
14	Serpens	5·5	16	18 16	−13 48	6611	*M*16‡
15	Cassiopeia	4	11	02 30	61 14	*IC*1805	‡
16	Cygnus	4	—	20 20	40 00	—	Large radio source, Cygnus X‡
17	Serpens	3·5	10	18 15	−12 16	6604	‡
18	Sagittarius	2·5	7	18 14	−16 45	*IC*4701	‡
19	Scorpius	2·5	7	16 36	−48 55	6188	‡
20	Scorpius	2	5·5	16 53	−40 23	—	Near galactic cluster *H*12‡
21	Cygnus	2	—	20 55	44 45	7000	North American Nebula, large source‡
22	Gemini	2	5·5	06 14	22 30	*IC* 443	Unusual galactic nebulosity
23	Cassiopeia	(1·5)	(4)	23 14	59 46	—	Radio detection uncertain‡
24	Sagittarius	(4·7)	—	17 47	−27 00	—	Galactic background

* The flux density given is twice the maximum observed in the 0·40° × 0·45° beam in one plane of polarization. It has not been corrected for the finite size of the source.

† See Baade, W., and Minkowski, R., *Astrophys. J.*, **119**, 206, 215 (1954).

‡ Bright hydrogen emission nebula, an H II region.

§ See McGee, R. X., and Bolton, J. G., *Nature*, **173**, 985 (1954).

band observed at metre wave-lengths mentioned earlier.

Eleven additional H II regions (Nos. 12–21 and 23) were detected during the second survey. Eight of these (Nos. 12, 13, 15, 18–21 and 23) appear to have been previously undetected at radio wave-lengths. The intensity of the Cygnus X source at wave-length 9·4 cm. agrees with the thermal-type emission spectrum found at longer wave-lengths[5]. No. 22 is a non-thermal source recently detected at metre wave-lengths and identified with the rare type of nebulosity similar to the double-loop nebula in Cygnus[13].

This work will be described in more detail elsewhere.

F. T. Haddock
C. H. Mayer
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U.S. Naval Research Laboratory,
Washington 25, D.C.
June 18.

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Ferromagnetic Resonance in Ferrites

Ferromagnetic resonance studies have been made on polycrystalline specimens of the ferromagnetic systems $(1-x)(LiFe_5O_8)x(CdFe_2O_4)$, $Li(Fe_{1-x}Al_x)_5O_8$, $Ni_{1-x}Zn_xFe_2O_4$ placed in resonant cavities operating at frequencies of 9,470, 23,940 and 34,400 Mc./sec.

The component oxides were mixed and pre-fired at 200 deg. below the final sintering temperature for 7 hr. The product was re-ground, pressed at 45 tons per square inch and sintered in air for 40 hr. at a temperature of 1,000° C. for the lithium–cadmium ferrites and 1,400° C. for the others. The furnace was then switched off and allowed to cool. Specimen densities of 90–97 per cent X-ray density were obtained. Spherical specimens produced in a device similar to that described by Bond[1] and ranging in diameter from 0·20 mm. to 1·40 mm. were mounted on a fine glass support which could be moved along the axis of a microwave cavity formed from a rectangular wave-guide. The strength of the externally applied magnetic field necessary to induce peak resonance loss, H_{res}, and the resonance line-width were studied as functions of frequency, specimen size, and position of the specimen along the cavity axis. The frequency/resonance field value for each resonance was determined by comparison with the ratio for the substance α-α-phenyl β-picryl hydrazyl, for which $g = 2{\cdot}0037 \pm 0{\cdot}0002$[2]. These studies have yielded the following information.

(1) The placing of a specimen directly on the cavity end wall increases the value of H_{res} below that necessary when the specimen is located at a magnetic antinode away from the cavity walls by an amount of the order of $\frac{2}{3}M_s$, where M_s is the saturation magnetization per unit volume of the specimen material. The wall effect may be considered to be due to the presence of a magnetic dipole induced in the end wall and is insensitive to variations in both frequency and specimen size. Resonance line-widths are not significantly affected.

(2) Measurements on specimens located at the first magnetic antinode from the end wall have shown that, before the onset of skin effects[3], the value of H_{res} varies with specimen size according to the law

$$H_{(\omega,\, r)} = H_{(\omega,\, 0)} + h_0\,(r/\lambda_i)^3,$$

where r is the radius of the specimen, λ_i is the effective internal wave-length for propagation in the material at an angular frequency ω, and h_0 is a constant. It is believed that the concentration of the oscillatory field along the axis of a specimen produces an effective shape of specimen deviating progressively with increasing radius from that of a sphere. The recognition of this relationship improves the extrapolation of resonance fields to zero radius of specimen.

(3) The extrapolated values of $H_{(\omega,\, 0)}$ have been found to fit, to within the experimental error of ± 10 Oe. at 9,470 Mc./sec., ± 20 Oe. at 23,940 Mc./sec. and ± 30 Oe. at 34,400 Mc./sec., a resonance relationship of the form reported by Okamura *et al.*[4], namely:

$$\omega = \frac{ge}{2mc}\,(H + H_i),$$

and yield the values for g and H_i given in Fig. 1 and Table 1. Magnetization measurements (unpublished) have shown that the cadmium ions in lithium cadmium ferrites enter tetrahedral sites, while the aluminium ions in lithium ferrite-aluminates for the most part enter octahedral sites leading to an anti-ferromagnetic structure for about 35 per cent aluminium replacement. The measured values of g tend to rise as this composition is approached, and the interpretation of this factor as the spectroscopic splitting factor, having regard to ferrite sub-lattice effects[5], leads to the conclusion that the value of g for a ferric ion depends on the particular lattice site which it occupies. For lithium ferrite, the values of g for ferric ions on either tetrahedral or octahedral sites must be at least 0·03 less than that for the spin

Table 1. Values of g and H_i derived from Resonance Measurements on Polycrystalline Specimens

Composition of specimen	g	H_i (Oe.)	$-0{\cdot}2\,K_1/M_s$
$LiFe_5O_8$	1·96 (5)	450	—
0·75 $(LiFe_5O_8)$ 0·25 $(CdFe_2O_4)$	1·97 (0)	320	—
0·65 $(LiFe_5O_8)$ 0·35 $(CdFe_2O_4)$	1·96 (9) ± 0·006	290 ± 15	—
0·50 $(LiFe_5O_8)$ 0·50 $(CdFe_2O_4)$	1·97 (7)	350	—
0·25 $(LiFe_5O_8)$ 0·75 $(CdFe_2O_4)$	1·99 (9)	90	—
$Li(Fe_{0\cdot8}Al_{0\cdot1})_5O_8$	1·97 (1)	320	—
$Li(Fe_{0\cdot6}Al_{0\cdot2})_5O_8$	1·99 (0) ± 0·008	290 ± 20	—
$Li(Fe_{0\cdot7}Al_{0\cdot3})_5O_8$	2·01 (1)	270	—
$NiFe_2O_4$	2·17 (3)	170	46
$Ni_{0\cdot75}Zn_{0\cdot25}Fe_2O_4$	2·07 (1) ± 0·006	230 ± 15	20
$Ni_{0\cdot5}Zn_{0\cdot5}Fe_2O_4$	2·05 (9)	190	21
$Ni_{0\cdot25}Zn_{0\cdot75}Fe_2O_4$	2·03 (6)	60	—

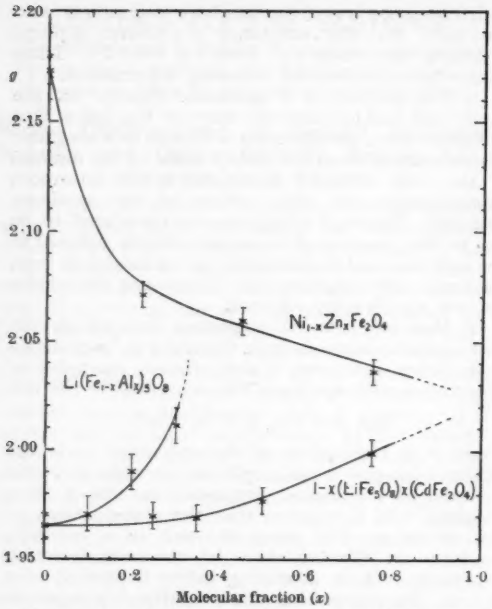

Fig. 1. Variation with ferrite composition of the g-factor derived from the resonance relationship $\omega = ge(H + H_i)/2mc$

only, namely, 2·00. Further consideration of the values for the cadmium- and zinc-substituted systems indicates that the effective values of g may also depend on the nature of the surrounding ions.

The treatment of a polycrystalline specimen as an aggregate of spherical non-interacting, randomly oriented crystallites shows that magneto-crystalline anisotropy may give rise to an effective field of the order of $-0{\cdot}2\ K_1/M_s$, where K_1 is the first-order anisotropy constant, assumed negative. Measurements on single crystals (unpublished) have given the values of this factor for three nickel–zinc ferrites and these are seen from the table to account for not more than a third of the field H_i.

(4) Resonance measurements at high levels of microwave power have shown a behaviour similar to that observed[6] in other ferrite systems. The resonance peak is reduced to half the low-field value for microwave field-strengths of the order of 10–100 Oe. when specimens absorb energy at rates of the order of 10^{12} ergs/c.c./sec. The resonance line-width does not appear to be a measure of the relaxation time associated with the interchange of energy between the absorbing mechanism and its surroundings, but may be considered as setting a lower limit to this time. If the concept of spin-wave excitation is used, the spin-wave states available for excitation must extend into the spin wave-number range of 10^6–10^7 cm.$^{-1}$, in which range a considerable contribution to the energy of excitation is normally to be expected from exchange effects. It is nevertheless possible that the resonance absorption proceeds by the induction of transitions between spin-wave states of this order of wave number, which at ordinary temperature would be the only ones vacant and therefore able to be excited. The formation of two spin waves of wave numbers $\bar{l}$ and $\bar{m}$ from one of wave number $\bar{k}$ in a cubic matrix with lattice constant a of ions of spin S and exchange integral J would require the energy:

$$l\omega = \Delta E = \hbar\gamma H + 2SJa^2(l^2 + m^2 - k^2),$$

with $\bar{k} = \bar{l} + \bar{m}$. This expression is of the form $\omega = \gamma(H + H_i)$, where:

$$H_i = 2SJa^2(l^2 + m^2 - k^2)/\hbar\gamma.$$

Values of k, l and m, all of the order of 10^6–10^7 cm.$^{-1}$, may be chosen to yield values of H_i consistent with experiment. On this interpretation the resonance line-width would then be determined in part by the distribution of transition probabilities for various values of H_i.

This work will be discussed in more detail in a later publication.

The materials used in this investigation were prepared by Dr. A. E. Carter, Messrs. P. E. Gallant and W. C. Greenstreet under the direction of Dr. A. J. E. Welch, in the Chemistry Department, Royal College of Science, London. I wish to thank Dr. Willis Jackson, at whose instigation this work was begun, for his interest and encouragement throughout its course.

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Use of X-Ray Film for comparing Radioactivities

Although the initial discovery of radioactivity resulted from its action on a photographic plate, electronic instruments have to-day become accepted as the first choice for detecting, and more particularly for measuring, radioactivity. It has, however, been shown that photographic emulsions can, with suitable methods for internal calibration, be used for giving reasonably accurate comparisons of radioactivity[1]. The present communication is concerned with a direct comparison of the accuracy obtained with a counter and with X-ray film, when used for comparing the radiation per unit area from a number of different sources. These were prepared by converting images from a photographic step-wedge quantitatively into silver iodide in the presence of iodine-131[2]. The relative quantities of silver, and hence of radioactivity, in the sources were compared: (*a*) by direct chemical analysis; (*b*) by a Geiger–Müller counter using a count of at least ten thousand for each specimen; (*c*) by making a series of autoradiographs with accurately determined exposure times and deriving the relative activity of each source from plots of density against log-exposure time; (*d*) by using visual density matching to determine (from the same autoradiographs) the exposure time needed by

Table 1

Relative silver masses determined by chemical analysis	Relative radioactivities (and hence silver masses) determined by: Geiger counter	Autoradiography and density measurement	Autoradiography and visual estimation: Observer 1	Autoradiography and visual estimation: Observer 2
16·1	13·9	15·1	17	17
38·6	37·0	39·5	42	35
58·8	58·7	59·4	59	52
77·5	76·3	77·8	79	70
91·3	92·2	93·3	91	79
100	100	100	100	100

each source to give a standard (but not measured) density. The quantities in the weaker sources were then expressed as percentages of the strongest source.

Table 1 shows that method (*c*) gave an accuracy comparable with that obtained by counting, while even without a densitometer accuracy adequate for semi-quantitative work was achieved.

Apart from its obvious usefulness in laboratories not equipped with a counter, autoradiography has certain other advantages: in its simplest form it requires no special equipment; it produces a permanent record of relative activities; in the sense that one sheet of film can be simultaneously exposed to a large number of specimens, it is equivalent to the use of a whole battery of counters, and as a result, autoradiography can simplify, or make unnecessary, corrections for decay. It also facilitates more accurate assessment of isotopes having short half-lives, and makes practicable comparisons of very weak sources which would each require a long time on a counter.

A full account of this work is being prepared for publication elsewhere.

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Bond-Lengths and Force Constants for Methane, Silane and Germane

In a recent paper by one of us (N. H. M.[1]), a detailed discussion of the electron distributions and potential fields for molecules of high symmetry was given on the basis of the Thomas–Fermi theory. In this work the nuclei of the outer atoms were smeared out over the surface of a sphere and the electrons then regarded as moving in the resulting spherically symmetrical field. A general discussion of the energy was also given, and the existence of a minimum in the energy curves was demonstrated. However, the theoretical bond-lengths were in poor agreement with the experimental values, and it was suggested that this might be due to the neglect of exchange.

We have now considered in detail the effect of exchange on the energy curves for methane (CH_4), silane (SiH_4) and germane (GeH_4), for which molecules the smoothing approximation referred to above seems physically very reasonable. The Thomas–Fermi electron densities obtained previously have been used as variation functions for calculating the energy including exchange, this being analogous to the procedure introduced by Scott[2] in his successful calculation of binding-energies for atoms. We are thus enabled to calculate the bond-lengths and the force constants for the totally symmetric vibrations of these three molecules, and the results are recorded in Table 1. For comparison, we also give the bond-length for methane when exchange is ignored[1] (the bond-lengths for silane and germane will be somewhat greater than this), together with an approximate value for the force constant for methane obtained by using the formula of Bowers[3] slightly outside its proper range of validity.

Table 1

	Bond-lengths (in A.) Experimental	Thomas–Fermi	Thomas–Fermi with exchange
CH_4	1·09	2·1	1·38
SiH_4	1·46	—	1·62
GeH_4	1·48	—	1·9
	Force constants (in units of 10^5 dynes/cm.)		
	Experimental	Thomas–Fermi	Thomas–Fermi with exchange
CH_4	20	1	9
SiH_4	11	—	5
GeH_4	10	—	3

It can be seen that the bond-lengths are improved considerably by the inclusion of exchange, the errors in the calculated bond-lengths for methane and silane being 27 and 11 per cent respectively. However, for germane the error increases again to about 25 per cent, which at first sight seems surprising in view of the fact that the Thomas–Fermi method should become more reliable as the number of electrons increases. Heath, Linnett and Wheatley[4], however, have concluded previously from a study of regularities in bond-lengths and force constants for a number of molecules that the bond in germane is probably "abnormally strong and short". If this is so, then it is not very reasonable to expect the Thomas–Fermi method, which distinguishes different atoms only by virtue of a change of scale depending on their atomic numbers, to be able to deal accurately with such a case. It is not so surprising, therefore, that by this method we find a larger deviation from the observed value for germane than in the case of silane.

As one would expect, the force constants are less satisfactory than the bond-lengths. Again, however, it is clear that exchange has a marked effect, the force constant for methane being improved by a factor of 9.

What has emerged from our calculations is that the exchange energy plays an essential part in determining bond-lengths and force constants from the present theory. Considering the simplified nature of the treatment, agreement with experiment is very reasonable. There is, however, some indication that the model we are using is least satisfactory for germane, in which the bonding is rather 'abnormal'. We are now investigating the application of the method to other molecules, and a detailed account of the work will be published later.

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Some 2 : 4-Diaminopteridines as Folinic Acid Antagonists

Burchenal and his colleagues have reported that 4-amino-10-methylpteroylglutamic acid (amethopterin) prolongs the lives of mice implanted experimentally with leukæmia[1], and that folinic acid antagonizes this therapeutic effect more potently than does pteroylglutamic acid[2]. Accepting the view that the antifolinic acid activity of amethopterin is related to its therapeutic effect in leukæmia, we have explored for such activity a number of 2 : 4-diaminopteridines[3,4,5] already known to be antagonists of pteroylglutamic acid[6], with the view of their possible clinical use.

Tests were carried out in a basal medium differing from that used by Barton-Wright *et al.*[7] in the use of 10 gm. sodium acetate, 6 gm. acid-hydrolysed casein, 200 μgm. riboflavin, 500 μgm. calcium pantothenate, 0·4 μgm. biotin, 100 μgm. aneurin, and 60 mgm. l-tryptophan per 500 ml. Diaminopteridines, named in the table, were diluted serially by two in tubes containing this double-strength medium, autoclaved, and the medium brought to single strength by sterile glass-distilled water containing appropriate levels of synthetic folinic acid (5-formyl-5 : 6 : 7 : 8-tetrahydropteroylglutamic acid). After sowing with a standardized inoculum of washed cells of *Leuconostoc citrovorum* (N.C.T.C. 7837), the tubes were incubated at 37° C. for 65 hr., when the acid produced was titrated with *N*/10 sodium hydroxide.

From these titrations we obtained the concentration of diaminopteridine required to inhibit acid production by 50 per cent, from which an inhibition factor was calculated as the ratio of molar concentrations of diaminopteridine to folinic acid in the medium. The geometric means of the inhibition factors obtained in two or more separate experiments (at each level of folinic acid) are expressed in the table. It will be seen that at the levels of 1, 5 and 25 ngm. of folinic acid per ml., the inhibition factor of di*iso*propylpteridine was constant. This indicates a competitive inhibition of the type first described by Woods[8] for sulphanilamide against *para*-aminobenzoic acid. The inhibition ceases to be competitive and becomes irreversible by folinic acid when higher concentrations of the di*iso*propylpteridine are used.

Inhibition of Acid Production of *Leuc. citrovorum* by 2 : 4-Diaminopteridines at Various Levels of Synthetic Folinic Acid

Serial No.	Substituents in 6 : 7 position	Synthetic folinic acid (ngm./ml.)	Mean inhibition factor*
0/154	None	5	> 58,390
0/58	dimethyl	5	22,880
0/69	diethyl	5	2,224
0/71	di-*n*-propyl	5	1,202
0/129	di*iso*propyl	1	90
,,	,,	5	98
,,	,,	25	90
,,	,,	125	34
,,	,,	625	10
0/128	di-*n*-butyl	5	1,495
0/113	di*iso*butyl	5	1,464
0/142	di-*sec.*butyl	5	69
0/37	di-*n*-amyl	5	315
0/103	di-*n*-hexyl	5	1,429
0/104	di-(*cyclo*hexylmethyl)	5	> 7,256
0/173	indolo-(2′,3′)-	5	> 1,979
0/120/74	1′-methylindolo-(3′,2′)-	5	241
0/120/91	1′-methylindolo-(2′,3′)-	5	364
0/164	1′-ethylindolo-(2′,3′)-	5	314
0/168	1′-*n*-propylindolo-(2′,3′)-	1	230
,,	,,	5	143
,,	,,	25	105
0/207	1-*n*-amylindolo-(2′,3′)-	5	307
0/181	benzylindolo-(2′,3′)-	5	4,932
0/63	diphenyl	5	2,082
0/137	dibenzyl	5	> 3,480
	4-amino-10-methylpteroylglutamic acid (amethopterin)	0·2	227
	,, ,, ,,	1	232
	,, ,, ,,	5	91
	,, ,, ,,	25	65
	,, ,, ,,	125	44
	4-amino-pteroylglutamic acid (aminopterin)	5	315

* Inhibition factor = ratio of molar concentrations of diaminopteridine to folinic acid to inhibit acid production by 50 per cent.

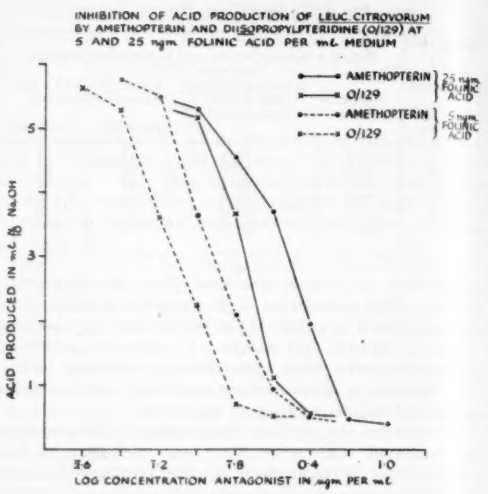

Fig. 1

In the present group of compounds, potency as folinic acid antagonists closely depends on structural details in the 6 and 7 positions of the pteridine ring. In the dialkyl series, peak activity was seen at the di*sec.*butyl-(0/142) and di*iso*propyl-(0/129) pteridines and in the indole series at the N-*n*-propyl (0/168). Activity was slight in the dimethylpteridine (0/58) and and in the diphenyl (0/63): it was not detected at all in unsubstituted diaminopteridine (0/154). The last three compounds, which were first synthesized by Mallette, Taylor and Cain[9], were found by Burchenal *et al.*[1] to be inactive against mouse leukæmia. Albert, Brown and Cheeseman[10] have prepared 2-amino-6 : 7-diethylpteridine and the corresponding 4-amino compound. We have found that the inhibition factors of these two monoaminopteridines at 5 ngm. folinic acid per ml. exceeded 60,000, while that of 2 : 4-diamino-6 : 7-diethylpteridine (0/69) was about 2,000. This indicates that the omission of one amino-group from the type of compound under investigation reduces antifolinic acid activity.

Since it has been reported that certain antimalarials, such as pyrimethamine[11] and 4 : 6-diamino-1-(*p*-chlorphenyl)-1 : 2-dihydro-2 : 2-dimethyl-*s*-triazine[12], possess antifolinic acid activity, it is not surprising that many of the pteridines here discussed are also potent antimalarials. In the present series, however, there does not appear to be any correlation between antifolinic acid activity, evaluated with *Leuconostroc citrovorum*, and ability to suppress *Plasmodium berghei* infections of mice. For example, di*cyclo*hexylmethyl-(0/104), di-*n*-butyl-(0/128) and di*iso*propyl-(0/129) pteridines are roughly equal in antimalarial activity[12], although they differ widely as folinic acid antagonists.

It will be seen from the table that there is little difference between the inhibition factors of the

*disec.*butyl- and di*iso*propyl-pteridines and of amethopterin at the level of 5 ngm. folinic acid per ml. A comparison of the activities of 0/129 and amethopterin at two levels of folinic acid is illustrated in Fig. 1.

We wish to thank Miss M. Boothroyd and Mrs. E. Harris for technical assistance, the American Cyanamid Company for supplies of synthetic folinic acid ('Leucovorin') and of amethopterin and aminopterin, Prof. A. Albert for the mono-amino-pteridines, and the directors of Allen and Hanburys, Ltd., for permission to publish this communication.

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A Chromatographic Method for the Estimation of Oleic and Linoleic Acids in the Presence of Straight-chain Saturated Fatty Acids

Two communications have recently appeared in *Nature* on the chromatographic separation of naturally occurring fatty acids or their esters. Nijkamp[1] uses a silica gel column for the separation of C_{10} to C_{20} saturated acids. Cropper and Heywood[2] have evolved a rapid vapour-phase technique for the separation of the methyl esters of saturated acids which they state will be investigated for use in the separation of linolenic, linoleic and oleic acids. In the course of investigations on the biochemical changes occurring during ripening of oil palm fruits, and during germination of oil palm and water melon seeds, we have developed a chromatographic method for estimating oleic and linoleic acids in the presence of saturated straight-chain acids from C_8 to C_{20}. This is based on the reversed-phase chromatographic procedure of Howard and Martin[3], later modified by Popják and Tietz[4] for the analysis of saturated acids from C_{10} to C_{18}, and by Silk and Hahn[5] for similar acids from C_{14} to C_{24}. Acetone–water mixtures varying from 45 per cent acetone (C_{16}) to 90 per cent acetone (C_{24}) have been recommended as eluting agents, the acids being estimated by titration with 0·01 *N* alcoholic potassium hydroxide to a bromthymol blue end-point.

Standard titrations on pure acids, without passage through the column, show that recoveries are influenced by the concentration of non-aqueous solvent. These titration curves indicate that the green end-point (*p*H 6·8–7·0 in aqueous solution) usually recommended gives incomplete neutralization for the longer-chain acids, and we have therefore adopted a blue-green end-point (*p*H 7·4 in aqueous solution). Results, after correction for reagent blank, then range from 99·2 per cent (caproic acid in 35 per cent acetone) to 95·4 per cent (stearic acid in 75 per cent acetone). Recoveries from the column agree well with these figures, indicating no significant loss by retention on the column. The amount of total fatty acid used varied from 2 to 50 mgm.

Table 1. Total Fatty Acids (per cent)

		Lauric	Myristic	Linoleic	Palmitic	Oleic
Oleic acid	Composition	—	—	—	—	100
	Found	—	—	—	—	94·3
Linoleic acid	Composition	—	—	98·5*	—	—
	Found	—	—	94·8	—	—
Mixture 1	Composition	11·7	28·0	—	35·1	25·2
	Found	11·2	27·6	—	31·4	27·6
Mixture 2 (high oleic)	Composition	—	13·3	9·7	7·2	68·9
	Found	—	12·4	9·3	7·7	66·2
Mixture 3 (high linoleic)	Composition	—	9·6	59·9	12·2	16·9
	Found	—	8·4	58·1	11·7	19·0

* Calculated from iodine value (Woburn), and checked by ultraviolet spectrophotometric method (ref. 8).

Using a 1·3 cm. × 30 cm. column, linoleic and oleic acids can be separated satisfactorily from one another but not from the saturated acids. Although linoleic is eluted slightly more slowly than myristic acid, mixtures of the two (in any proportions) form a single peak: oleic has the same R_F value as palmitic acid. Figures can therefore be obtained for the total quantities of (i) myristic + linoleic acids, and (ii) palmitic + oleic acids.

Various methods were considered for the separation of these saturated and unsaturated acids. The standard lead salt method is unsatisfactory in the presence of myristic acid. Chromatographic separation of the unsaturated acids as the 2.4-dinitrobenzenesulphenyl chloride derivatives[6] proved difficult and was rejected. The final method adopted was a Bertram[7] (alkaline permanganate) oxidation to destroy the unsaturated acids, followed by estimation of the remaining saturated acids by chromatography. Experiments with pure oleic and linoleic acids indicated complete loss of the original acid peaks after oxidation at room temperature for 16–18 hr. Both acids were converted into products which were either not extracted by light petrol (b.p. 40°–60°) at the end of the Bertram oxidation or which had a high R_F value and could be separated completely from the C_{13} or longer-chain saturated acids. After oxidation under these conditions, palmitic acid can be recovered in 95–98 per cent yield, and myristic acid in 90–96 per cent yield. The results for the analyses of different mixtures can be seen from Table 1. Amounts used in the oxidation varied from 15 to 100 mgm. of total fatty acid; an aliquot of this containing 8–25 mgm. was then chromatographed. Further details of this method will be published elsewhere. We are extending it to the analysis of other unsaturated acids.

In this brief communication it is impossible to acknowledge all the help we have received from various sources; but we should like to express our indebtedness to Prof. W. T. Williams for his encour-

agement, and to Prof. N. K. Adam for a gift of pure fatty acids.

Since submitting the above, our attention has been directed to a paper by Savary and Desnuelle[9], who employ a slightly different oxidation procedure for the estimation of oleic and linoleic acids in simpler mixtures. It is hoped to examine this method more fully in a later communication.

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Effect of Cortisone on the Neonatal Rat

Neonatal rats have been treated with cortisone acetate (Merck ; Roussel) in doses of 0·25–5 mgm./day subcutaneously, control litter mates being given the same dosage of suspending medium. The experiments were undertaken primarily to test the effect upon microglial immigration and transformation in the brain. Hortega's neonatal 'fountains' were found to be completely suppressed within 24–36 hr. of a single dose of 2·5 mgm. of cortisone, and in older animals myelination was retarded.

The treated animals showed a striking failure to grow, or in some cases a retarded growth followed by loss of body weight ending in death (Fig. 1). Such animals presented all the signs of pituitary failure (Fig. 2). They were small and shrivelled, with very little subcutaneous fat and a marked failure of hair growth. Without exception they showed a considerable degree of exophthalmos. In some cases their eyes actually opened before those of the control litter mates. Their appearance corresponded with that produced in chick embryos by Karnofsky *et al.*[1] by cortisone treatment. There was a general decrease

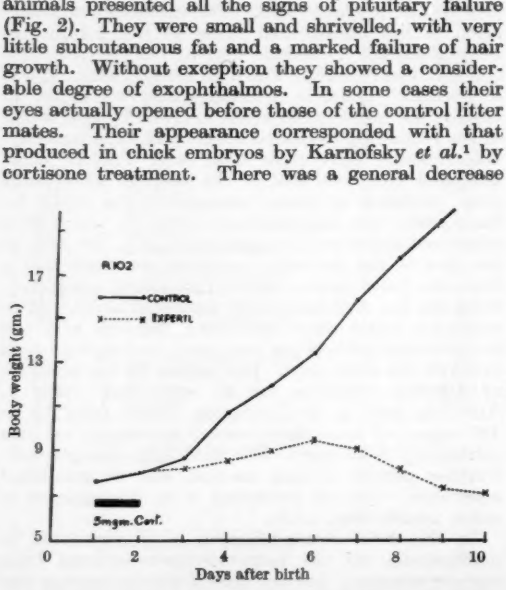

Fig. 1

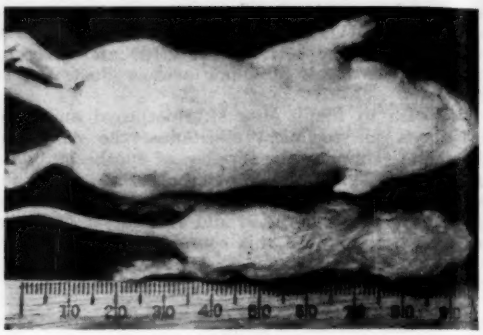

Fig. 2

in lymphoid tissue, and pituitaries were small and degenerate on histological examination. A detailed account of these changes will be published elsewhere.

Cortisone is known to depress adrenocorticotrophic activity of the anterior lobe of the pituitary gland[2]. It is also known to inhibit growth of the embryo chick after the eighth to tenth day of incubation[1]. On the other hand, it has been held not to diminish thyrotrophic secretion of the adenohypophysis but possibly, indeed, to increase it[3].

Exophthalmos has been produced in adult rats by prolonged exhibition of cortisone[4]. Such treatment may produce thyroid depression—"corticogenic hypothyroidism"—so that the exophthalmos might be attributable to thyrotrophic activity of the pituitary, since the thyrotrophic hormone is known to be capable of producing the condition in rats[5]. Aterman and Greenberg[4], however, are inclined to attribute the exophthalmos produced by cortisone in the rat to a direct alteration of the physico-chemical state of the tissues within the orbit, and there is then no necessity for assuming a stimulating effect of cortisone on thyrotrophic activity of the adenohypophysis in the present experiments.

Two points may be considered: (1) the simultaneous 'damping down' by cortisone of adrenotrophic activity and growth hormone of the anterior pituitary invites the speculation that the two principles may, under physiological conditions, be part of an articulated complex at the time of their elaboration[6]; (2) there may be a possibility of utilizing 'functionally hypophysectomized' neonatal rats as test animals for adrenocorticotrophic hormone activity—a modification of the method of Sayers, Sayers and Woodbury[7].

I wish to thank Dr. Max Reiss for helpful discussion of results. The cortisone used was supplied by the Medical Research Council, and the work was carried out while in receipt of financial aid from the Council.

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Role of High-molecular Weight Components in the Respiratory Activity of Cell-free Extracts of *Aerobacter aerogenes*

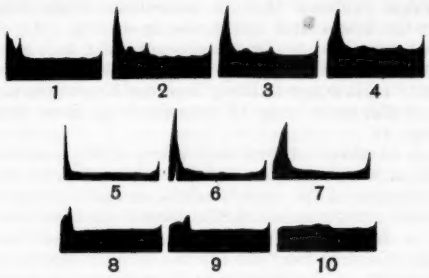
It has been shown that clear cell-free extracts from a strain of *Aerobacter aerogenes* catalyse the oxidation of glucose, glucose-6-phosphate, hexose diphosphate, pyruvate and succinate[1]. As the rate of oxidation with these substrates was not appreciably modified by 20-min. centrifugation in a field of 15,000 *g*, and as the extract was transparent by transmitted light, it was obvious that the enzyme systems concerned were attached to very small elements.

The experiments reported here show that the bulk of the succinic oxidase system, in these cell-free extracts, is bound to one, or possibly two, high-molecular weight components, which have sedimentation constants of approximately 40 and 22 *S* respectively. The same components are also necessary, in addition to soluble factors, for the oxidation of glucose, pyruvate, citrate, α-ketoglutarate and fumarate.

The strain of *Aerobacter aerogenes* used and the methods of cultivation have been described previously[1]. The bacteria from a 24-hr. culture were washed three times with twenty volumes of distilled water by centrifugation and the well-packed cells were ground by hand in a cold mortar for 2–3 min. with three parts (w/w) of a very fine 'Pyrex' glass powder (passed through a 200-mesh sieve) and extracted with 2·5 parts (w/v) of ice-cold distilled water. A first centrifugation at 4,000 *g* for 20 min. removed the glass powder, the intact cells and the larger cell debris, and the supernatant was centrifuged again at 18,000 *g* for 20 min., to give a clear supernatant (Sup. 1). This fraction was again centrifuged for 90 min. at about 110,000 *g* in a model *L* Spinco centrifuge, yielding a supernatant (Sup. 2) and a small gelatinous pellet which was resuspended in one-fifth the volume of Sup. 1 of 0·05 *M* phosphate buffer *p*H 7·0 to give fraction *P*. The preparation was kept at 0–4° C. throughout these manipulations.

The various fractions Sup. 1, Sup. 2 and *P* were examined in the ultracentrifuge. As seen in Figs. 1–4, three major components were found in Sup. 1, with sedimentation constants of about 40, 22 and 9 *S* respectively. In Sup. 2 (Figs. 5–7) only the third component (9 *S*) was present, while fraction *P* contained the two larger components only (40 and 22 *S*, Figs. 8–10). Thus, by centrifugation at about 110,000 *g* for 90 min., it was possible to separate the two larger components from the rest of the extract. Of these two components, that of 40 *S* was the major one; it showed a sharp boundary in the ultracentrifuge, and its molecular weight, based on ultracentrifugal data, is of the order of 1–3 millions. Further experiments are required to determine accurately the molecular weights and to study the homogeneity of both the 40 and 22 *S* components.

Schachman, Pardee and Stanier[2] found that cell-free extracts prepared by different methods and from different species of bacteria all gave essentially similar patterns on examination in the ultracentrifuge. The extracts contained four major components with sedimentation constants of about 40, 20–30, 9 and 5 *S*. An electron micrograph of the purified 40 *S* fraction showed that it was formed of particles which appeared to be spherical with a diameter of about 150 A., and the molecular weight of these elements, calculated either from ultracentrifugal or electron microscopic data, was about one million. Although they did not give any data on the matter, Schachman *et al.*[2] stated that the 40 *S* fraction contained "considerable amounts of ribonuclease, catalase, apyrase, formic dehydrogenase and succinodehydrogenase". Siegel, Singer and Wildman[3], in the course of their study of high-molecular weight components of normal and infected *E. coli* cells, observed very similar ultracentrifugal patterns, and the data presented here are in good agreement with those given by both groups of authors.



Ultracentrifugal patterns of Sup. 1 (1–4, time interval 600 sec., average speed 38,400 r.p.m., increased after picture 3 to 43,100 r.p.m.); Sup. 2 (5–7, time interval 840 sec., average speed 43,000 r.p.m.); and *P* (8–10, time interval 300 sec. between 8 and 9, and 900 sec. between 9 and 10, average speed 39,600 r.p.m.)

The ability of Sup. 1, Sup. 2 and *P* to oxidize various substrates was tested in Barcroft differential manometers at 36° C., in the presence of 0·05 *M* phosphate buffer *p*H 7·0 and with potassium hydroxide in the centre well. 1·5 ml. of either Sup. 1 or Sup. 2 and 0·3 ml. of *P* were used in each manometric flask in a total volume of 3 ml. The results, presented in Table 1, show that Sup. 1 contained the catalysts necessary for the oxidation of glucose, pyruvate, citrate, α-ketoglutarate, fumarate and succinate. Sup. 2 alone was inactive in the oxidation of these substrates, while *P* contained the bulk of the succinic oxidase system present in Sup. 1. Further fractionation of *P* will show whether the 40 *S* component alone carries all the enzymes of the succinic oxidase system. Whatever the answer, however, the experiments reported here show that the very fine particles—or macromolecules—of fraction *P*, of which the largest have a molecular weight of the order of 1–3 millions, support a complete succinic oxidase system, and, with the soluble factors found in Sup. 1, are able to catalyse the oxidation of some intermediates of the citric acid cycle.

It has been known for some time that clear cell-free extracts from some bacterial species are able to catalyse the oxidation of various substrates, including Krebs-cycle intermediates. Thus Stone and Wilson[4]

Table 1. Oxidation of Various Substrates by Fractions from Clear Cell-free Extracts of *Aerobacter aerogenes*.

Results given as Q_{O_2} (μl. oxygen uptake/mgm. protein/hr.) corrected for blanks. Substrate concentration: 0·03 *M*. Experimental conditions: see text

	Sup. 1	Sup. 2	*P*
Glucose (with 0·04 m.mol. diphosphopyridine nucleotide	49	4	0
Pyruvate (with 0·04 m.mol. diphosphopyridine nucleotide and 36 units of coenzyme A)	16	1	0
Pyruvate (with 0·04 m.mol. diphosphopyridine nucleotide, no coenzyme A)	10	1	0
Citrate	5·5	0	0
α-Ketoglutarate	6	0·7	0
Fumarate	8	0	0
Succinate	8	0	42

presented evidence that in an extract from *Azotobacter* the citric acid cycle was operating. As this extract was said to be translucent, and in view of the results of Schachman *et al.*[2] with different species of bacteria, it is not unlikely that the largest particles were of the same order of magnitude as those found in Sup. 1.

It is of great interest that some of the reactions, which in animal tissues are known to depend upon the integrity of the mitochondria, can take place in a bacterial extract in which the largest element would have a diameter of about 150 A., and therefore a volume of nearly one-millionth that of a mitochondrion.

However, as the activity of these bacterial extracts in the oxidation of some of the citric acid cycle intermediates is low compared with that of mitochondria, it is not inconceivable that when the cells are disrupted a cellular organization, necessary for optimum activity of the enzyme systems concerned, is disturbed.

I am indebted to Dr. P. Johnson for carrying out the experiments in the analytical ultracentrifuge and to Miss J. Moyle for her assistance in running the preparative Spinco centrifuge.

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Effects of Intraventricular Administration of Substance P

The presence of substance P in the central nervous system was first shown by Euler and Gaddum[1]. According to recent work on the distribution of this substance in the brain[2,3], the largest amounts are found in the basal ganglia, the hypothalamus, the midbrain and the grey matter of the spinal cord. Nothing is known about the action and function of substance P in the nervous system. We have now observed tachypnœa and hyperpnœa produced by substance P injected into the third ventricle of the rabbit and the cat.

Substance P was prepared and purified by the method of Euler[4] and Pernow[3]. Cow intestine was cut into pieces, boiled in water at *p*H 4 and the filtrate concentrated and precipitated with ammonium sulphate at 70 per cent saturation. The precipitate was purified by adsorption on aluminium oxide and elution with methanol. The activity of the preparation, tested on isolated guinea pig ileum, was 100–150 units per mgm. Substance P was dissolved in Ringer's solution. The volume injected varied between 0·05 and 0·2 ml. A preparation of substance P inactivated with crystalline chymotrypsin was used as a control solution.

The animals were anæsthetized with urethane (rabbit) and 'Nembutal' (cat). Substance P was injected through a cannula inserted in the intersection of the coronal and sagittal sutures at right angles to the vertex of the skull. The position of the tip of the cannula in the third ventricle was checked after each experiment by injection of aniline blue. Respiration was measured quantitatively by using a body-plethysmograph.

Intraventricular injection of 5 units of substance P produced, after a latent period of about five minutes, a successively increased rate of respiration of 30–50 per cent with a maximal effect occurring after 10–15 min. With 20 units the effect was even more pronounced. There was also an increase in the amplitude of the respiratory movements. Usually the injections produced a slight, gradual rise in the blood pressure of about 10 mm. mercury. These effects lasted from 20 min. to more than two hours. A pronounced tachypnœa and increased respiratory amplitude were also observed in unanæsthetized rabbits after injection of 10 units of substance P. No effect was obtained with control injections of Ringer's solution or inactive solutions of substance P.

When injections were made into paraventricular tissue and the solution did not enter the ventricular system, no consistent or lasting effects upon the respiration were recorded.

Recently, the effects of intraventricular injections of different drugs have been studied by Feldberg and Sherwood[5]. Tachypnœa was observed after injections of histamine, 5-hydroxytryptamine, adenosine triphosphate, hexamethonium, *d*-tubocurarine and atropine.

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Development of Tolerance to Ganglion Blockade by Methonium Compounds

The clinical observation that tolerance follows the repeated administration of hexamethonium salts was reported by Smirk and others[1]; and Smirk[2] has reported that the tolerance to hexamethonium salts was effective also in reducing the effects of other methonium salts. No reports concerning similar phenomena in animals have been found, and I have not found published observations as to the mechanism whereby tolerance occurs. This preliminary report is concerned with the mechanism by which tolerance is developed to the ganglion-blocking action of methonium salts.

Studies of the mydriatic effect of these agents in mice, and of blockade of the superior cervical sympathetic ganglia in the cat, indicate that tolerance of the ganglia to the effects of these substances follows their repeated administration to the whole animal. The local application of methonium compounds to isolated autonomic ganglia, however, did not give rise to any tolerance; but similar isolated preparations taken from animals which had previously been made tolerant by repeated doses of methonium salts were found to have become almost insensitive to these substances. The application of blood from tolerant animals and patients was found to confer tolerance on isolated ganglia from non-tolerant animals.

The superior cervical ganglia of bilaterally nephrectomized cats recovered from the effect of an

intravenous injection of hexamethonium, although the recovery was slower than in normal animals. In nephrectomized cats, tolerance occurred as rapidly as in normal animals. By contrast, the ganglia of eviscerated or dehepatized cats did not develop tolerance after an intravenous injection of hexamethonium; but, when by a cross-circulation experiment the isolated liver of another animal was incorporated into the circulation, tolerance developed as in the whole animal.

Solutions of hexamethonium were assayed for this substance biologically and by a modified bromphenol blue method[2] before and after perfusion through an isolated liver, and before and after the solution was incubated with liver homogenates. The concentration of hexamethonium was rapidly reduced until none could be detected. The solution of hexamethonium treated with liver homogenate, when applied to isolated ganglion, produced resistance to the effects of further hexamethonium. It was concluded that the action of the liver on hexamethonium gave rise to a substance which competed with hexamethonium at the ganglion without itself producing any important degree of ganglionic block.

Studies on the nature of the liver principle which inactivated hexamethonium suggested that it is an enzyme, in that alterations in *p*H, temperature and the action of certain chemical substances reduced its activity and it is completely inactivated by trypsin digestion. The principle has been isolated in comparatively pure form, and is very active in destroying hexamethonium.

Estimations carried out on the excretion of hexamethonium have suggested that about 60 per cent of a parenteral dose is excreted in the urine. Evidence is available suggesting that the remainder is metabolized, presumably in the liver.

The work has given information which throws light on the mechanism of the development of toleration to the ganglion-blocking action of methonium compounds, and may throw light on the mode of the production of the ganglionic-blocking effects of these agents.

Papers embodying the results of this investigation will be published elsewhere.

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Galactopoietic Action of Thyroxine in Cattle kept in Subtropical Countries

A perusal of the available literature shows that no systematic work has been so far carried out to study the effects of the oral administration of thyroxine on the daily milk yield of different indigenous breeds of buffaloes and cows, bred in subtropical countries such as western Pakistan[1]. Two preliminary experiments were carried out to study the effects of the daily feeding of thyroxine in suitable doses, for a period of four weeks, on the daily milk yield in a six-year old Murrah buffalo and a five-year old Shaiwal cow kept in Lahore during October–November 1953.

The experimental animals (two buffaloes and two cows) were selected in such a way that the age of the animals, number and stage of lactation and the milk yield of the experimental animals were very close to that of the controls. The experiments were started about eight and twenty weeks after calving in the buffaloes and cows respectively. The animals were given orally 15 gm. of thyroprotein (containing 0·75 per cent *l*-thyroxine on bioassay) per animal. Thyroprotein under the registered name of 'Protamone' was kindly supplied by Cerophyl Laboratories, Kansas City, U.S.A. This preparation was adopted because it affords a ready means of administration of thyroxine by farm workers. The animals were milked twice a day and the daily milk yield of each animal was recorded. As the body temperature gives some indication of the physiological state of the animal body, the rectal temperatures of the animals were recorded daily. The mean minimum and maximum atmospheric temperatures for the months of October and November were 63·0° and 93·9° and 50·0° and 82·0° F. respectively, and the mean relative humidities were 56 and 69 per cent.

During the four-week period, the daily yields of the control and treated buffaloes were $22{\cdot}7 \pm 0{\cdot}027$ and $27{\cdot}1 \pm 0{\cdot}018$ lb. respectively. Statistical analysis of the results showed that thyroxine therapy resulted in a highly significant increase in the daily milk yield of the experimental buffalo ($t = 16{\cdot}815$). The average daily milk yields of the control and experimental cows were $12{\cdot}0 \pm 0{\cdot}11$ and $13{\cdot}7 \pm 0{\cdot}24$ lb. and the increase was not significant.

The mean daily temperatures of the experimental animals, when compared with those of their respective controls, did not show any significant difference throughout the experimental period, indicating that the administration of thyroxine did not affect the animal body adversely.

There are some indications that an optimal increase in the daily milk yield of the lactating animals can only be obtained if thyroxine therapy is started at an early stage of lactation.

This work is being continued.

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Occurrence of *trans*-Acids in Animal Fats

Bertram's discovery[1] that ox and sheep fats, and butterfat, contain traces of *trans*-Δ^{11} octadecenoic (vaccenic) acid has been confirmed by other investigators[2,3], who have shown that this acid also occurs in traces in lard.

Using infra-red absorption technique, Swern *et al.*[4] recently found that beef fat contained not traces, but 5–10 per cent of *trans*-acids. These consisted of a mixture of Δ^{9} and Δ^{11} octadecenoic acids. By a similar procedure Cornwell *et al.*[5] found 5·0–9·7 per cent of *trans*-acids in butterfat. In the present work, undertaken to elucidate the origin of these *trans*-acids, we have estimated by infra-red absorption their content in the body fats of various animal species.

The table shows a marked difference in the *trans*-acid content of ruminants as compared with non-ruminants. The small amounts of *trans*-acids in pig fat could be derived from the skim-milk diet, as

Trans-UNSATURATED-ACID CONTENT OF ANIMAL DEPOT FATS

Species	Diet	Fat	Percentage *trans*-acid
Non-ruminants			
Rat	High carbohydrate 'fat-free'	Total body-fat	Not detected
Horse	Pasture	External and internal fatty tissues	Not detected
Pig	Skim-milk	Perinephric	0·9
Rabbit	Pasture	Abdominal cavity	Not detected
Ruminants			
Ox	Pasture	Beef tallow	4·5
Sheep	Pasture	Mutton tallow	11·2
Deer	Pasture	Perinephric	3·5

butterfat contains *trans*-acids, and it has been previously shown by Sinclair[6] that *trans*-acids (elaidic acid) when present in the diet are deposited in the depot fat.

Swern *et al.*[4] suggested that the *trans*-acids present in depot fat may have been produced endogenously from a *cis* monoethenoid (oleic) acid by oxidases. If this were so, then from the *trans*-acid contents of the fats shown in the table one could infer that such oxidases are present in ruminants, but not in non-ruminants. However, oxidases have been found in the tissues of rats, pigs and rabbits[7]. We consider, therefore, that the presence of *trans*-acids in ruminant depot fats could be better explained on the basis of bacterial action in the rumen.

We have found about 9 per cent of *trans*-acids in the fatty acids isolated from the rumen contents of pasture-fed sheep. (The rumen contents of living sheep were obtained through the courtesy of Dr. A. T. Johns, of the Department of Scientific and Industrial Research, Grasslands Division, Palmerston North, New Zealand.) No appreciable amounts of *trans*-acids were found in pasture lipids.

The mechanism of *trans*-acid formation in the rumen can be deduced from the work of Reiser[8], who showed that rumen bacteria hydrogenate linolenic acid to linoleic acid. Hydrogenation of unsaturated acids is accompanied by partial formation of *trans*-isomers, and this could explain the presence of *trans*-acids in the rumen.

This work is in progress, and the detailed results will be published elsewhere. In the meanwhile, the results now recorded serve to accentuate even more sharply the wide differences between the fat metabolism of ruminants and of non-ruminants, already referred to by one of us[9].

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Relation of Nitrogen Supply to the Molybdenum Requirement of Tomato Plants grown in Sand Culture

AGARWALA[1] has shown that molybdenum deficiency decreased the growth and ascorbic acid content of cauliflowers grown in sand culture, irrespective of whether nitrogen was given as nitrate, or as nitrite, ammonium compounds or urea. Except with nitrite, molybdenum deficiency also induced symptoms of whiptail[2] which serve as criteria for the diagnosis of molybdenum deficiency. In later work[3], molybdenum deficiency induced whiptail also in plants given nitrite or glutamic acid. As the whiptail condition is apparently confined to brassica crops[2,4] and might indicate a special role for molybdenum for this genus, it was desirable to investigate the relation of molybdenum requirement to nitrogen source in some other plant where symptoms of molybdenum deficiency are of a different type. Tomato was chosen as it is a sensitive and well-known indicator for molybdenum deficiency[4].

Plants were grown in sand culture by methods already described[2]. Purified calcium carbonate was mixed in the sand to prevent injury by ammonia, and all nutrient salts including the different nitrogen compounds were purified by treatment with copper sulphate and hydrogen sulphide. Nitrogen sources were: nitrate, nitrite, ammonium sulphate, ammonium nitrate, ammonium nitrite, urea or glutamic acid.

Growth was markedly reduced by omission of molybdenum irrespective of nitrogen source ($p < 0{\cdot}001$ for all treatments, except ammonium sulphate $p < 0{\cdot}05$). The percentage dry matter in leaves was also reduced with most nitrogen sources ($p < 0{\cdot}05$–$0{\cdot}001$) but was quite unaffected by molybdenum supply in the presence of urea or glutamic acid. Ascorbic acid[5] and dehydroascorbic acid were both similarly decreased by molybdenum deficiency irrespective of nitrogen source, but to differing degrees of significance as follows: nitrate, ammonium nitrate ($p < 0{\cdot}001$); ammonium sulphate, ammonium nitrite ($p < 0{\cdot}01$); glutamic acid ($p < 0{\cdot}05$); urea, nitrite ($p > 0{\cdot}05$). The ratio of ascorbic to dehydroascorbic acids was remarkably constant, remaining about 1 : 1·1 irrespective of treatments.

Total chlorophyll content was markedly decreased by molybdenum deficiency *only* in the nitrate or ammonium nitrate treatments ($p < 0{\cdot}001$). There were slight decreases or increases in most other treatments, but with ammonium sulphate there was a notable increase with omission of molybdenum ($p < 0{\cdot}01$).

In all sets of data there was a marked difference between the magnitude of the molybdenum effects in the presence of nitrate or ammonium nitrate and those produced with the other nitrogen sources. In each instance the nitrogen to molybdenum interaction was highly significant ($p < 0{\cdot}001$), except dehydroascorbic acid ($p < 0{\cdot}01$).

Thus, although evident generally in all treatments, the molybdenum effect and possibly its requirement are significantly less with non-nitrate sources of nitrogen than in the presence of nitrate. It is concluded at present that chlorophyll production is independent of molybdenum supply unless nitrate is present.

The visual symptoms observed in this experiment merit special note. Severe symptoms typical of

molybdenum deficiency[4] were clearly recognizable *only* in the nitrate and ammonium nitrate treatments. They were similar in both except for a somewhat darker colour of the green areas in the latter treatment. In the other treatments plants were practically symptomless and normal in appearance though smaller, except for occasional sporadic incidence of either dark brown marginal areas in old leaves (mainly with glutamic acid), or sudden wilting and withering without loss of chlorophyll in apical leaflets of midstem leaves (mainly with urea or nitrite). These symptoms were relatively slight in extent and were confined to plants given non-nitrate sources of nitrogen and no extra molybdenum.

The evidence presented here supports the conclusion that molybdenum is essential for tomato, irrespective of whether nitrogen is given as nitrate or in a number of other forms at different stages of reduction, but that relative requirements depend on the nitrogen source. Full details and results of work now in progress will be reported elsewhere.

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Copper Sulphate as an Aquatic Herbicide

During the course of an experiment in the use of copper sulphate against bilharzia snail hosts in the season 1951–52, it was noted that the water-weed vegetation appeared to be affected by the treatment.

Two canals, branching off the general Gezira irrigation system at the same point, were hand-weeded in July 1951 and treated with 30 parts per million of crystalline commercial copper sulphate for snail control. Three canvas bags containing copper sulphate crystals were then hung in the flowing water just below the head regulator of the first canal, and refilled as required. The second canal received no further treatment. It is estimated that throughout the watering season, all water entering the first canal was treated at an average rate of 1 part per million with copper sulphate. By March 1952, towards the end of the watering season, it was apparent that there were large differences in both weed and snail populations in the two canals under experiment, and a survey carried out at that time showed that though the second canal had a heavy population of both snails and pondweed species, neither weeds nor snails were to be found in the first, throughout the whole 9½ km. of its length.

During the period April–July 1952 a certain regrowth of weed occurred, no doubt owing to the interrupted flow of water (for domestic purposes only) during this 'closed' period. In July 1952, with the resumption of watering for the new crop, the application point of the copper sulphate was removed 5 km. upstream so as to command a small branched system including the two canals of the previous year's experiment. This was all, except the 'second' canal referred to, treated again with 30 p.p.m. of copper sulphate, and then continuously with an amount afterwards estimated at 2 p.p.m. No weeding was carried out until March 1953, when an examination revealed that (1) no weeds grew nearer than 3 km. downstream of the point of application; (2) only patches of *Potamogeton nodosus* appeared able to grow within 10 km. of the point of application, though (3) at points below this some *Najas pectinata* and a little *Chara globularis* were found; (4) no bilharzia snails were found; (5) at no time were watering difficulties encountered on account of weed growth.

Further experiments are being carried out by the Sudan Ministry of Irrigation in order to ascertain if modifications of this method are practicable as a weed control treatment.

Hamid Sharif El Din
(Public Health Officer)
Ministry of Health, Sudan.
K. Wilson Jones
(Senior Economic Botanist)
Research Division, Ministry of Agriculture, Wad Medani, Sudan. April 3.

Culture of Insect Tissues

Goodchild[1] has recently described attempts to culture *in vitro* the tissues of *Rhodnius prolixus*, and suggested two possibilities that might enable the successful establishment of cultures. The two suggestions are (1) to replace glass surfaces by mica, or cover them with a film of wax, and (2) to enrich the culture medium with an extract of *R. prolixus* embryos. Similar suggestions were included in a series of experiments that I have recently performed. Cultures capable of growth and of yielding subcultures have not so far been established, and it appears that the problems of insect tissue culture are more complex than has hitherto been appreciated.

Attempts have been made to culture the following tissues: hæmocytes (from cetoniid larvæ), *Bombyx mori* L. pupæ, and from *Periplaneta americana* L. nymphs and adults; gonads from *B. mori* pupæ; embryonic cells from eggs of *Drosophila melanogaster* Meig. two hours old; imaginal disks (eye, leg, wing, antenna) of *D. melanogaster*; epidermal cells of cetoniid larvæ; fore and midgut of *P. americana*.

The following media were used: (1) *B. mori* pupal blood, (2) aqueous extracts of *Drosophila* pupal and adult tissues, (3) Trager's[2] medium, (4) adult and embryonic insect tissue extracts in various combinations with vitamins, glutathione, cystine, cholesterol, concentrations of free amino-acids approaching those of insect blood[3], fowl plasma and chick embryo extract, (5) fowl plasma and chick embryo extract.

The following techniques were used: hanging drops of fluid; hanging drops with solid clots of fowl plasma and other ingredients; perforated 'Cellophane' sheets covered by liquid medium on cover slips; cover slips containing a drop of agar on which were placed drops of liquid medium. All the cultures were incubated at 25° C.

The antibiotics chloromycetin and sodium sulphadiazine were used in some media. They did not appear to have any effect on the tissues.

Survival of various tissues up to a week was observed, but continued growth was not obtained. In certain tissues, notably *Bombyx* hæmocytes, a

syncytium was formed within 24 hr. of setting up the cultures and survived for six days. Long processes from fat-body cells were produced within 24 hr., resembling vertebrate fibroblast cultures, but no mitoses were observed in them and they did not increase in size during a six-day survival period.

The reasons for the difficulty in establishing insect tissue cultures are worthy of further investigation. I consider it unlikely that technical improvements in conventional methods such as Goodchild[1] has mentioned will be sufficient to establish insect tissue cultures. Further developments would appear to demand greater knowledge of hormone balance, tissue continuity and growth substances of insects.

T. D. C. Grace

Division of Entomology,
Commonwealth Scientific and Industrial
Research Organization,
P.O. Box 109, City,
Canberra. April 20.

[1] Goodchild, A. J. P., *Nature*, **173**, 504 (1954).
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[3] Buck, J. B., Chapter 6 in Roeder's "Insect Physiology" (John Wiley, N.Y., 1953).

Occurrence of Two East American Species of Crabs in European Waters

Recently, two species of crabs, widely distributed on the Atlantic coast of the United States of America, were found in Danish waters. Since there is a possibility that especially one of them may be living in Britain and elsewhere but has been overlooked, I report here some details of the recent and of previous finds of the two species.

(1) Blue crab or common edible crab, *Callinectes sapidus* Rathbun. On September 20, 1951, a live female of the blue crab was caught in a plaice net in the Sound north-east of Copenhagen. It was kept alive for almost a year and moulted one month after the capture, increasing its width from 141 to 177 mm.

There are a few previous records from Europe. In 1900 a male was taken in south-west France[1]. Den Hartog and Holthuis[2] give two certain records from Holland (River Zaan and Amsterdam), and in a letter Dr. L. B. Holthuis, Leyden, has informed me that in July 1951 a specimen (about 120 mm.) was caught by a fisherman in the Nordzeekanaal.

In America the blue crab ranges from Nova Scotia to Uruguay, but is common only along the American coast from Cape Cod to Louisiana. Especially the young prefer sheltered bays or estuaries, and are occasionally found in fresh water. Correspondingly, all the five European records are from fresh water or more or less brackish water.

(2) *Rhithropanopeus harrisi* (Gould). In November 1953 Mr. Erik Rasmussen found plenty of crabs of this species on piles in the South Harbour of Copenhagen. They were all quite small (6–7 mm.). In the middle of the ice winter another visit to the known locality in the harbour only gave four specimens in all, ranging in width from 6·8 to 10·5 mm. This part of the harbour was the only area free of ice, because waste water from a nearby factory raised the temperature to 6° C.

In eastern America this species occurs locally in estuaries from Nova Scotia to Mexico. Previous records outside this area are: (1) San Francisco Bay[3]; (2) Coos Bay, Oregon[4]; (3) Holland, where until 1949 the crab was regarded as endemic (it was known as the Zuiderzee crab, *Heteropanope tridentata* Maitland, but is now considered a subspecies, *R.h. tridentata* Maitland)[5]; (4) Flemhuder Lake near the Kiel Canal in North Germany[6]; (5) estuaries of the Rivers Dnieper and Bug in the Black Sea[7].

Transportation of *Callinectes sapidus* to Europe, and of *Rhithropanopeus harrisi* to Holland (before 1874, when the Zuiderzee crab was described) and to the Black Sea may have taken place in various ways. Many examples are known of crabs clinging to ships' sides or living in growths of algae, etc., on ships' hulls (*Pachygrapsus transversus*, *Plagusia chabrus*, *P. depressa* and *P. tuberculata*, *Planes minutus*, *Carcinides maenas*, *Menippe convexa*, etc.). In my opinion, this mode of transportation does not, however, apply either to *C. sapidus* or to *R. harrisi*. The former never occurs on piles, etc., or seeks shelter in crevices (as do the species mentioned above) and the latter is a brackish-water crab which could scarcely withstand transportation for several weeks through sea water of high salinity. It is more likely that the two species have crossed the Atlantic in the ballast tanks of ships. This was probably the way in which the mitten crab (*Eriocheir sinensis*) was brought to Europe, as shown very convincingly by Peters and Panning[8]. Another possibility in the case of the blue crab may be active swimming, presumably in the shadow of floating sea weeds or wood, tree trunks, etc., carried by the Gulf Stream. During the

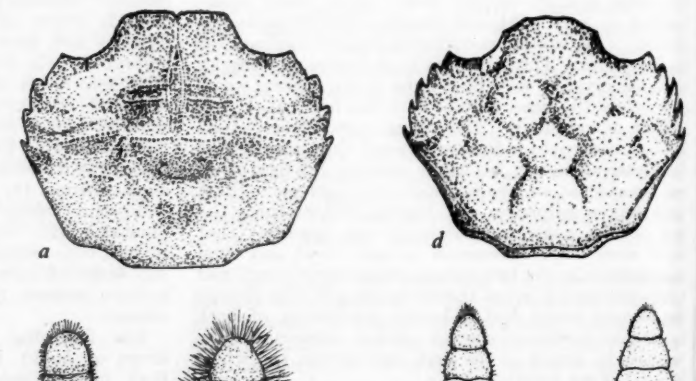

Fig. 1. (*a–c*) *Rhithropanopeus harrisi*; (*d–f*) *Carcinides maenas*; (*a*, *d*) carapace; (*b*, *e*) male abdomen; (*c*, *f*) female abdomen

Galathea Deep Sea Expedition, I several times saw coastal swimming crabs together with numerous coastal fish, other Crustacea, etc., seeking shelter and shadow under such floating objects, far from land.

It is reasonable to suppose that finds of *Callinectes sapidus* are normally recorded, since this crab is so big and conspicuous. But *Rhithropanopeus harrisi* never exceeds some 25 mm. and can easily be mistaken for a juvenile shore crab, *Carcinides maenas*. It can be distinguished by the presence of only three antero-lateral teeth and the conspicuous lines of granules on the carapace (Fig. 1*a* and *d*).

In Holland the two species are known to occur together[9]; but at Copenhagen *Rhithropanopeus* seems to fill an ecological niche, occurring in the South Harbour where the salinity (normally 9–12‰) is too low for *Carcinides*, which only penetrates into the Middle Harbour.

TORBEN WOLFF

Zoological Museum,
University of Copenhagen.
April 2.

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Modified Horizontal Migration Method in Paper Chromatography

VERY recently, Matthias[1] has described a modified technique which may be looked upon as a combination of uni-dimensional and circular paper chromatography. In this case, substances to be chromatographed are applied near the edge of a strip of paper, the end of which is made in the form of a cone; thus the substances are at first radially distributed, which results in better separation.

We have developed a further modification. Whatman No. 1 filter paper sheet (18·5 cm. × 18·5 cm.) or circular paper (18·5 cm. diameter) is cut as shown in Fig. 1. The black rectangles indicate openings of equal size on paper at equal intervals; thus, *A*, *B*, etc., may be looked upon as a number of strips joined together. The samples are applied at *X* and, as in circular paper chromatography, paper wicks of equal size (2·0 cm. × 1·5 cm.) are inserted at *W*, so that one wick develops two samples at a time. The piece of paper (sheet or circular) is then placed between two Petri dishes of the same diameter (16·0 cm.), inverted one over the other, in which there is another smaller Petri dish (10·5 cm. diameter) containing the developing solvent. Development starts

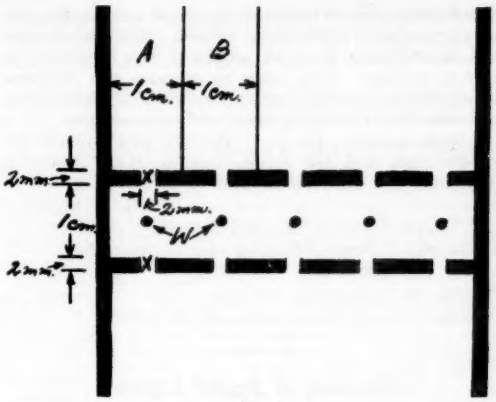

Fig. 1

simultaneously through all the wicks and is complete within 30 min. Detection and identification of the samples are as usual. Fig. 2*a* shows the resolution achieved by the modified technique; twenty-two samples of varying concentrations were chromatographed on a sheet of paper 11 cm. × 18·5 cm. The solvent was allowed to travel a distance of 7 cm. The effective travel can be doubled if the wicks are transferred from the centre to the periphery of the paper, as shown earlier[2] for circular paper chromatography; but in this case only half the number of samples can be analysed. The 'cuts' in the paper can be of various shapes and sizes, provided that the solvent front moves radially at first. The poor resolution of the same sample on ordinary strip without 'cuts' is shown in Fig. 2*b* for comparison. Since there is clear separation of the constituents by the modified technique, quantitative analysis by elution can be done very easily in this case.

As was pointed out earlier, all these improved methods depend upon the radial distribution of the chromatographed substances, at least in the beginning of development. In the case of strip chromatography, spots are formed which are generally elongated in the direction of the flow of solvent. This results in the merging of spots of close R_F values. In circular paper

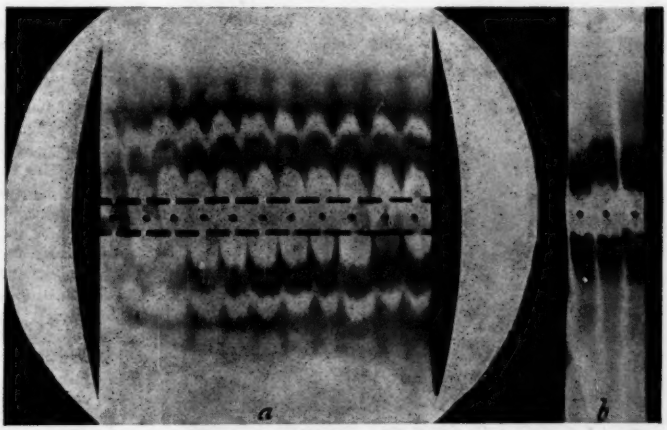

Fig. 2. Samples of amino-acid mixture of varying concentration which have been chromatographed with butanol : acetic acid : water (40 : 10 : 50)

chromatography or in these improved techniques, the substances form either rings or arcs; that is, elongation takes place at right angles to the direction of flow of solvent. This helps to increase the distance of separation between substances of close R_F values and therefore results in improved separations.

I wish to thank Dr. S. C. Roy, of this College, for his interest, and Dr. D. P. Burma, Bose Research Institute, Calcutta, for helpful criticism.

N. C. Ganguli

Department of Applied Chemistry,
University College of Science and Technology,
Calcutta 9. March 18.

[1] Matthias, W., *Naturwiss.*, **41**, 17 (1954).
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Staining of Bound Lipids

Methods at present used for staining bound lipids either give an inadequate result histologically or depend on chemical reactions not characteristic of lipids as a class.

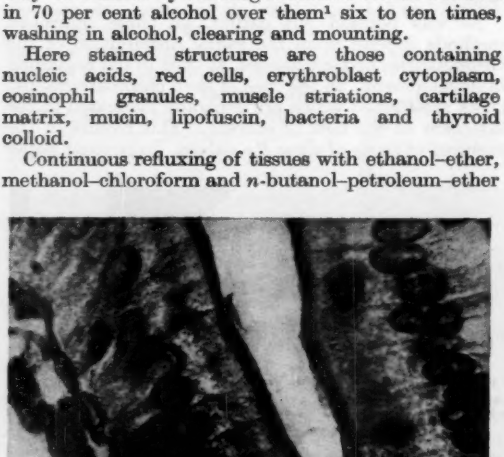
It has been found that if paraffin sections of variously fixed tissues are washed in water for several hours, and then rinsed in alcohol, they are well stained by 2 per cent sudan black *B* in acetone at 37° C. Staining is carried out in an airtight container, is progressive, taking one to twelve hours, and is followed by rinsing in xylol and mounting.

Structures stained include those containing nucleic acids, various cytoplasmic particles, nerve cells and processes, corpora amylacea, lipofuscin, basement membranes, reticulin, collagen, cartilage matrix, mucin, fibrin, amyloid, muscle striations, pituitary and thyroid colloid, bacteria and epithelial brush borders.

Alternatively the sections, washed as above, or exposed to dry heat at 60–65° C. for some hours, may be stained by burning saturated sudan black *B* in 70 per cent alcohol over them[1] six to ten times, washing in alcohol, clearing and mounting.

Here stained structures are those containing nucleic acids, red cells, erythroblast cytoplasm, eosinophil granules, muscle striations, cartilage matrix, mucin, lipofuscin, bacteria and thyroid colloid.

Continuous refluxing of tissues with ethanol–ether, methanol–chloroform and *n*-butanol–petroleum–ether mixtures progressively reduces stainability, little being left after extraction for two weeks. The difficulty of disrupting some lipoprotein bonds by solvents alone is well known[2].



Intestinal epithelium of guinea pig; alcohol-fixed; washed 24 hr.; acetone – sudan black 6 hr. Showing staining of brush border, cytoplasmic granules, nuclei and basement membrane

It is postulated that washing dissociates protein from laminated lipoproteins, allowing access to the stain[3].

This hypothesis is supported by the effect of mild peptic digestion (0·2 per cent pepsin in 0·05 *N* hydrochloric acid for 30 min. at 37° C.) and of soaps[4] (1 per cent sodium ricinoleate at *p*H 7 for 1 hr. at 37° C.), after either of which procedures sections stain intensely without further washing.

This evidence suggests that these methods stain lipids bound to protein, and possibly to carbohydrate and nucleic acids.

It is hoped to publish a full account of this and related work in due course.

M. C. Berenbaum

Department of Pathology,
Chase Farm Hospital,
Enfield, Middlesex.
April 12.

[1] Sheehan, H. C., and Whitwell, F., *J. Path. Bact.*, **61**, 269 (1949).
[2] Lovern, J. A., "The Mode of Occurrence of Fatty Acid Derivatives in Living Tissues" (H.M. Stationery Office, 1942).
[3] Grundland, I., and Bulliard, H., *C.R. Acad. Sci., Paris*, **207**, 184 (1938).
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Extension of Range of the Angwantibo

I wish to correct a pardonable error in the review of "The Overloaded Ark" published in *Nature* of May 15, one in fact which I myself held until very recently. *Arctocebus calabarensis* is not found only in the forests of the British and French Cameroons. Two specimens of it have, a short time since, been taken in the Mamu River Forest Reserve, a patch of isolated remnant high forest situated some thirty miles east of Onitsha on the left bank of the Niger.

This is an interesting if not important discovery, since it extends the known range of this animal well beyond what is with some justification regarded as a faunal frontier precluding several animals of the main central African forest block from the West African block—the Cross River basin. The Angwantibo, which in its main habitat cannot truly be described as a "very rare" lemuroid, was certainly regarded as one of the chief of these; so, too, was *Hylarnus batesi*, which has likewise been captured well to the west of the Cameroons.

The high forests lying between the Cross River and the Niger, that is, in the densely populous Eastern Region of Nigeria, have been very largely destroyed, and it is thus difficult to determine precisely the limits of the central African block. In our present state of knowledge there appear, however, to be indications from plants as well as animals that it is the somewhat insignificant Cross River rather than the Niger which forms the dividing line. To a scientific worker interested in animal distribution, investigation of the few remaining and little-known forest remnants of the Eastern Region of Nigeria, rather than the over-done Cameroons, would be well rewarding.

D. R. Rosevear
(Inspector-General of Forests)

Lagos,
Nigeria.

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

CURATOR (with a degree in geology) IN THE GEOLOGY DEPARTMENT—Head of the Geology Department Imperial College, South Kensington, London, S.W.7 (July 23).

LECTURER (with special interests in animal husbandry) IN AGRICULTURE—The Registrar, The University, Nottingham (July 28).

DEMONSTRATORS (with an honours degree in chemistry) IN CHEMISTRY—The Registrar, College of Technology, Manchester (July 29).

SCIENTIFIC OFFICER or SENIOR SCIENTIFIC OFFICER (with a first- or second-class honours degree in physics or chemistry, and with several years experience in the study of surface chemistry), to work on problems associated with the surface chemistry of materials of interest in the nuclear energy field—The Establishment Officer, Atomic Energy Research Establishment, Harwell, Berks (July 29).

LECTURERS (with a good honours degree in electrical engineering) IN ELECTRICAL ENGINEERING—Head of the Electrical Engineering Department, City and Guilds College, London, S.W.7 (July 30).

RESEARCH ASSISTANT (with a good degree in botany and high qualifications in chemistry and with physics to at least introductory level) TO THE PROFESSOR OF PLANT BIOPHYSICS in the Department of Botany, to study problems in growth and senescence of apple cell walls using electron microscopy and other physical methods—The Registrar, The University, Leeds 2 (July 30).

SENIOR LECTURER (with high academic and research qualifications) IN ORGANIC CHEMISTRY—The Clerk to the Governors, Woolwich Polytechnic, London, S.E.18 (July 30).

ASSISTANT IN MATHEMATICS, and an ASSISTANT IN STATISTICS—The Secretary, The University, Aberdeen (July 31).

CHAIR OF CHEMISTRY—The Secretary, The University, Aberdeen (July 31).

LECTURER (preferably with an interest in low-temperature physics or in the theory of the solid state) IN PHYSICS, at St. Salvator's College—The Secretary, University of St. Andrews, College Gate, St. Andrews (July 31).

DEMONSTRATOR (with a good honours degree in chemistry or biochemistry, and prepared to engage in research in biochemistry with a view to obtaining a higher degree in this subject) IN THE DEPARTMENT OF CHEMISTRY AND BIOCHEMISTRY—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (August 3).

SCIENTIFIC ASSISTANT (with a knowledge of systematic zoology and/or foreign languages), for duties which will include abstracting, indexing and proof reading—Commonwealth Bureau of Agricultural Parasitology (Helminthology), Winches Farm Drive, Hatfield Road, St. Albans, Herts (August 4).

PRINCIPAL SCIENTIFIC OFFICER (with an honours degree in civil engineering or Corporate Membership of the Institute of Civil Engineers) AT THE ROAD RESEARCH LABORATORY, Harmondsworth, Middlesex, to take charge of full-scale experiments in bituminous road construction and occupy a senior position in the section dealing with research on bituminous materials—The Civil Service Commission, Scientific Branch, 30 Old Burlington Street, London, W.1, quoting S4355/54 (August 12).

ASSISTANT IN RESEARCH IN ANIMAL PHYSIOLOGY; an ASSISTANT IN RESEARCH IN SOIL CHEMISTRY, and an ASSISTANT IN RESEARCH IN AGRICULTURAL ENGINEERING—The Secretary, School of Agriculture, Downing Street, Cambridge (August 13).

LECTURER or ASSISTANT LECTURER (preferably with experience of University teaching and with special qualifications in petrology or geophysics) IN THE DEPARTMENT OF GEOLOGY—The Secretary and Registrar, The University, Southampton (August 13).

SENIOR LECTURER IN EDUCATION at the University of Sydney, Australia—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Australia, August 14).

COLLEGE LECTURER IN ELECTRICAL ENGINEERING, and a COLLEGE LECTURER IN MECHANICAL ENGINEERING—The Secretary, University College, Cork, Ireland (August 16).

LECTURER (with a good honours degree in mechanical engineering and practical experience in industry and teaching) IN MECHANICAL ENGINEERING—The Principal, Wigan and District Mining and Technical College, Wigan (August 16).

ASSISTANT LECTURER or DEMONSTRATOR (with a good honours degree in chemistry or biochemistry) IN CHEMICAL PATHOLOGY—The Registrar, The University, Manchester 13 (August 25).

LECTURER (preferably with qualifications in the fields of human and regional geography, and a special knowledge of the regional geography of Monsoon Asia and/or the South-West Pacific) IN GEOGRAPHY, at Victoria University College, Wellington, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

LECTURERS (2) (with a special interest in one or more of the following fields: clinical psychology (with therapeutic experience), experimental and statistical, physiological, social, industrial) IN PSYCHOLOGY, at the University of Natal—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (South Africa, August 31).

PROFESSOR OF PHILOSOPHY at the University of Otago, Dunedin, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, August 31).

SENIOR LECTURER IN PURE MATHEMATICS at the University of the Witwatersrand, Johannesburg, South Africa—The Secretary Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (Johannesburg, August 31).

PLANT PATHOLOGIST (with a good degree in botany, including mycology, and preferably with postgraduate research experience or equivalent training in plant pathology or mycology) for research on fungal diseases of hops and fruit—The Secretary, East Malling Research Station, near Maidstone, Kent (September 1).

LECTURER IN APPLIED PHARMACOLOGY AND THERAPEUTICS—The Dean, St. Thomas's Hospital Medical School, London, S.E.1 (September 6).

LECTURER (well qualified in organic chemistry, and preferably with experience of the chemistry of vegetable tannins or synthetic dyestuffs) IN THE DEPARTMENT OF LEATHER INDUSTRIES—The Registrar, The University, Leeds 2 (September 13).

W. J. REES RESEARCH FELLOWSHIP, tenable in the Department of Refractory Metals in the Faculty of Metallurgy—The Registrar, The University, Sheffield (September 15).

SENIOR TECHNICIAN (with some training in zoology and experience in laboratory work, and preferably with a practical knowledge of taxidermy and modelling) IN ZOOLOGY, at Auckland University College, Auckland, New Zealand—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (New Zealand, September 30).

AGRONOMIST/PLANT BREEDER (with a degree in agriculture or botany, and preferably with some postgraduate experience) on the Research Staff of the Empire Cotton Growing Corporation, Aden, to work on general problems of agronomy and plant breeding, and selection work on the irrigated cotton crop, and to some extent on food crops; and a SOIL CHEMIST or PHYSICIST, to study the soils in Aden Protectorate and possibly Somaliland—The Secretary, Empire Cotton Growing Corporation, 12 Chantrey House, Eccleston Street, London, S.W.1.

ASSISTANT EXPERIMENTAL OFFICER (with at least H.S.C. in science or mathematics) IN THE DEPARTMENT OF ATOMIC ENERGY, Risley, for technical information duties, which include preparation of bibliographies, bulletin of journal references, and maintenance of indexes—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 638.

ASSISTANT EXPERIMENTAL OFFICERS (with at least H.S.C. in mathematics or science subjects, or equivalent) IN THE DEPARTMENT OF ATOMIC ENERGY, Capenhurst, near Chester, for (*a*) work in a small computing section (after a period of training); (*b*) theoretical investigations, under supervision, of problems arising in the development of power producing reactors and diffusion plant; (*c*) assisting in research concerned with development in fields such as fluid dynamics, mass spectrometry, heat transfer and general physics—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 637.

ASSISTANT LECTURER IN THE DEPARTMENT OF PURE MATHEMATICS—The Registrar, University College of Wales, Aberystwyth.

CHEMICAL ENGINEER (with an honours degree, A.R.I.C., A.M.I. Chem.E., or equivalent qualifications, and at least three years experience in an industrial research organization) IN THE DEPARTMENT OF ATOMIC ENERGY, Sellafield, Cumberland, to lead a team working on chemical engineering problems connected with the development of new processes—The Department of Atomic Energy, Industrial Group Headquarters, Risley, Warrington, quoting 632.

CHEMIST, to work in the United Birmingham Hospitals Department of Clinical Endocrinology, on an investigation of protein hormones—The House Governor, Birmingham and Midland Hospital for Women, Showell Green Lane, Birmingham 11.

ELECTRONICS TECHNICIAN, to work on the 8 MeV. Linear Accelerator—The Director, Radiotherapeutic Research Unit, Hammersmith Hospital, Ducane Road, London, W.12.

LECTURER, Grade IIa (with an honours degree or equivalent qualification, and preferably industrial and/or research experience) IN PHYSICS—The Principal, Paisley Technical College, Paisley.

LECTURER IN MARKET GARDEN AND GLASSHOUSE CROPS—The Clerk to the Governors, Essex Institute of Agriculture, Writtle, Chelmsford, Essex.

LECTURER (with special qualifications in pure mathematics) IN MATHEMATICS—Head of the Mathematics Department, Imperial College, London, S.W.7.

MASTER TO TEACH PHYSICS to Scholarship level—The Warden, The College, Llandovery, Carmarthenshire.

PHYSICIST (preferably experienced in instrumentation, with particular reference to the inspection and testing of metallic materials)—The British Non-Ferrous Metals Research Association, 81 Euston Street, London, N.W.1.

PHYSICIST, to continue fundamental research on surface electrification of polymers—The Secretary, British Rayon Research Association, Heald Green Laboratories, Wythenshawe, Manchester.

PHYSICIST (with a good honours degree) for technical assessment and development of inventions chiefly in the applied physics and scientific instrument field—The Secretary, National Research Development Corporation, 1 Tilney Street, London, W.1.

PHYSICIST or ELECTRICAL ENGINEER (with an honours degree in physics or electrical engineering), for work with a 1-million-volt cascade generator—Dr. J. F. Loutit, Medical Research Council Radio Biological Research Unit, Atomic Energy Research Establishment, Harwell, Didcot, Berks.

RESEARCH ASSISTANTS IN CHEMISTRY, PHYSICS AND MATHEMATICS—The Northern Polytechnic, Holloway, London, N.7.

RESEARCH OFFICER (with a first-class honours degree in a natural science and at least two years postgraduate research experience, preferably of freshwater fish and fisheries) with the East African Fisheries Research Organization, to carry out research into the ecology and/or physiology of fish—The Director of Recruitment, Colonial Office, Great Smith Street, London, S.W.1, quoting BCD.195/194/02.

SCIENTIFIC ASSISTANT (with a degree in agriculture or natural science, and a knowledge of French and German and ability to write clear concise abstracts in English), for duties which will include examining and abstracting world scientific literature on grassland and field-crop research—The Director, Commonwealth Bureau of Pastures and Field Crops, Hurley, near Maidenhead, Berks.

TECHNICIAN or SENIOR TECHNICIAN (with some experience of electronic equipment) in the Londonderry Laboratory for Radiochemistry—The Secretary, Science Laboratories, University of Durham, South Road, Durham.

REPORTS and other PUBLICATIONS

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Institution of Civil Engineers. Conference on the North Sea Floods of 31 January/1 February, 1953: a Collection of Papers presented at the Institution in December, 1953.) Pp. 242+19 plates. (London: Institution of Civil Engineers, 1954.) 25s. [186

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Department of Scientific and Industrial Research. Memoirs of the Geological Survey. Special Reports on the Mineral Sources of Great Britain. Vol. 36: The Cambro-Ordovician Limestones and Dolomites of the Ord and Torran Areas, Skye, and the Kishorn Area, Ross-shire. By H. E. Wilson. Pp. iv+30. (London: H.M. Stationery Office, 1954.) 2s. 6d. net. [186

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